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Fact Book on High-Technology and Energy-Related Higher Education in the West

Prepared by the WICHE Information Clearinghouse
in cooperation with the WICHE Economic Development Program
and the Western Technical Manpower Council

Western Interstate Commission for Higher Education

WICHE

WICHE, the Western Interstate Commission for Higher Education, is a nonprofit regional organization. It helps the thirteen member states to work together to provide high-quality, cost-effective programs to meet the education and manpower needs of the West. Member states are Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. Through its Information Clearinghouse, WICHE provides information to assist higher education and governmental policy makers in the West.

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Foreword

In 1980, the Western Interstate Commission for Higher Education (WICHE) conducted a regional conference on the role of higher education in the economic development of the West. One of the recommendations from participants of that conference was that regional or state planning councils involving government, higher education, and industry be formed to identify critical manpower needs and plan together to meet those needs "particularly in high demand fields such as microelectronics and energy occupations" of the West. In 1981, another WICHE-sponsored conference dealing with critical choices for higher education in the West urged states and institutions of higher education to "address more effectively the employment needs of graduating students and employers, through consultation with business and government."

By 1982, spurred by deteriorating economic conditions affecting both public and private sectors, most states had in fact created various planning or advisory councils that included educators, government officials, and business and industry representatives. WICHE formed a thirteen-state Western Technical Manpower Council to examine high-technology industry issues for their regional implications and to devise appropriate strategies for consideration in each state.

It was quickly apparent that decision makers faced sorting through scattered, varying, and often conflicting information as they attempted to establish comprehensive economic and education policies to pursue for their state, region, institution, or industry. WICHE concluded it could assist these policy makers by bringing this information together in a "fact book" that would provide pertinent data on aspects of education and manpower problems in high-technology and energy industries.

This publication, therefore, uses a series of charts, graphs, and tables to describe:

- the importance of science and engineering to the nation and the West;
- the supply and demand for the high-technology and energy-related labor force;
- the particular issues that relate to higher education's special role as provider of skilled workers, technicians, and professionals who are essential in keeping America in the forefront of technological advancement and worldwide competition.

To the extent possible, this fact book presents the latest, most reliable information available with an emphasis on data that can be most readily and accurately compared. While several states are involved in gathering these types of data, we have used national sources because of the improved comparability among the states. In some cases, data do not reflect recent changes in aspects of high-technology and energy-related manpower problems; for example, there have been recent large increases in numbers of women enrolling in high-technology programs, but these will not be reflected in degrees received until 1984 or 1985. Readers are encouraged to submit comments concerning the data to WICHE so that we are kept updated concerning new information in this swiftly changing area of higher education and the economy.

We hope that this report will be used in conjunction with the strategies presented in a special report from the Western Technical Manpower Council as each state and each sector establishes policies to meet the manpower needs of new high-technology and energy development. The council's report, *High-Technology Manpower in the West: Strategies for Action* (Publication No. 2A117), will be presented to policy makers at each of thirteen individual state meetings during 1983. Copies are available from WICHE.

This fact book presents a broad range of projections of demand for high-technology and energy-related manpower. Because of the many variables that affect manpower demand, especially in these fields, WICHE cannot conclude from the data that supply and demand of such manpower is in or out of balance in any particular locale. What we can conclude is that these industries are vital to the western states, that higher education must be able to sustain high-quality programs in engineering and related sciences, and that states, institutions, and business and industry are well advised to work together to assure quality education for future manpower, research, and technical assistance in these critically important areas.

Boulder, Colorado
January 1983

Phillip Sirotkin
Executive Director
Western Interstate Commission for Higher Education

Introduction

This fact book presents information relating to numerous problems that threaten higher education's ability to provide quality education to sufficient numbers of persons needed in engineering and the computer and geophysical sciences—fields seen as essential to the economic growth and well being of the region and the nation.

This report presents information on: overall national productivity growth, the relative concentrations of high-technology and energy industry and manpower in the West, national projections of demand for engineers and scientists, and the current and projected supply of personnel in these fields. Data are displayed for the western region, the nation and, wherever feasible, for individual states.

The fact book concludes with data related to several important issues or problems that face higher education: the shortage of faculty in engineering and computer science, the large and growing number of foreign nationals among doctorate recipients in engineering, the problems of inadequate or obsolete equipment, and the general problem of underpreparedness in science and mathematics among recent high school graduates.

Definitions

The terms "high technology" and "energy-related" as they pertain to both the supply of trained manpower and specific occupations are ambiguous. For purposes of inclusion in this fact book, which is oriented toward educational planning, we have defined these fields in terms of the academic disciplines that educate or accredit individuals for employment. Thus, this report concentrates on the following disciplines or academic subject areas:

High-Technology Fields

Engineering
- aerospace
- bioengineering
- computer
- electrical

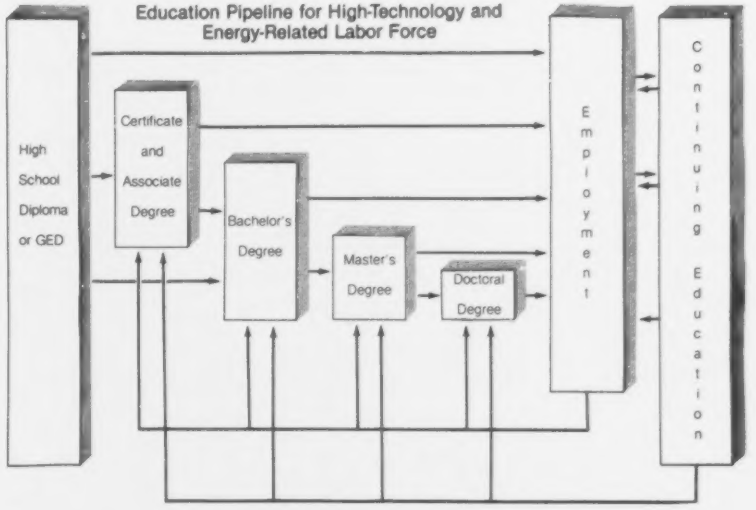
Computer Science
- computer and information sciences
- information sciences and systems
- data processing
- computer programming
- systems analysis

Energy-Related Fields

Engineering
- chemical
- environmental
- mechanical
- mining
- nuclear
- petroleum

Geological Sciences
- geology
- geochemistry
- geophysics and seismology

Most of the displays pertain to baccalaureate and graduate degree programs. Although much of the demand for personnel in high-technology and energy-related industries is for persons with less than baccalaureate training, comparable data are not available. The supply of technicians varies greatly from state to state and is obviously an important factor in educational program development in many states. Recent anecdotal evidence suggests that two-year colleges continue to play an important and vital role in providing training to meet the demands of local industries. The importance of two-year colleges (and of continuing education) is apparent in the accompanying figure, which depicts the educational system as it relates to high-technology and energy-related industries.



The classification of industries into high-technology or energy-related is also somewhat ambiguous. The displays in this report use the following manufacturing and service industries to define high-technology employment and energy-related employment:

High-Technology Industries

drugs
ordnance and accessories
office machines
computing equipment
accounting and calculating equipment
electrical and electronic machinery, equipment and supplies
electrical and electronic components
aircraft and parts
guided missiles, space vehicles and parts
tanks (military) and tank components
measuring, controlling, analyzing, optical and photographic equipment
computer and data processing services
photographic equipment
computer and data processing services

Energy-Related Industries

coal mining and production
oil and gas extraction
petroleum refining
pipelines, except natural gas
gas production and distribution

These industries were selected from the list of Standard Industrial Classifications (S.I.C.'s), which are contained in the United States Office of Management and Budget's *Standard Industrial Classification Manual.*

These data on industries and employment are not without their limitations:

- While the figures for the various states have been collected in a consistent manner, they are not intended for state-by-state comparisons. The energy and high-technology industries are dependent on the size and skill of the labor force in the states, indigenous natural resources, and locations of the states.
- Employment figures in many cases are estimates based on ranges and thus are subject to error.

Organization

This fact book is divided into four parts. Part I describes, by means of graphic and tabular displays, the importance of science and technology to the United States and the West and the segments of the economies of the western states that are devoted to high-technology and energy-related industries.

Part II is divided into three sections. The first presents several indicators or projections of demand for engineers and scientists in high-technology and energy-related industries. The second reviews available data on the supply of engineers and scientists in the West and the nation. Much of the information presented in this part is taken from original sources and produced especially for WICHE's use. The final section of Part II attempts to bring together this information on supply and demand in such a way that comparisons are possible.

Part III presents information on several problems that affect the supply of engineers and scientists and the quality of their training: the shortage of faculty in engineering and computer science, the low levels of graduate enrollment in those fields, the numbers of foreign nationals enrolled and the general problems of underprepared high school graduates.

The final part is an appendix which contains tabular data on enrollment and earned degrees in engineering, computer science, and geological science.

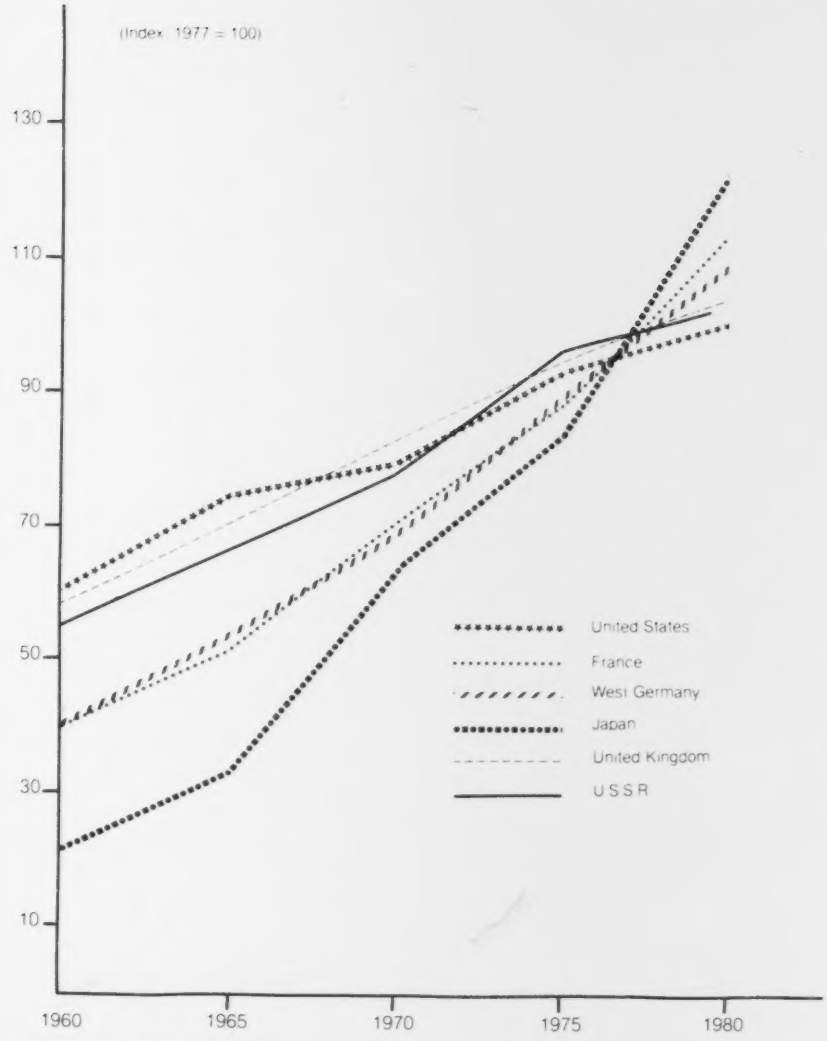
The displays in this report are intended to provide useful information on a variety of topics or concerns. They are illustrative but not exhaustive of the issues or problems and should be viewed in that context. For further information about the materials presented, please contact the Information Clearinghouse, WICHE, P.O. Drawer P, Boulder, Colorado 80302, (303) 497-0221 or 0227.

Part I
Importance of Science and Technology to the United States and the West

The exhibits in this section describe the overall importance of high-technology and energy-related industries to the United States and, especially, to the western states. The first three exhibits set the stage by depicting the rates of productivity and research and development expenditures for the United States and other nations.

Exhibit 1

Relative Change in Productivity* in Manufacturing Industries for Selected Countries



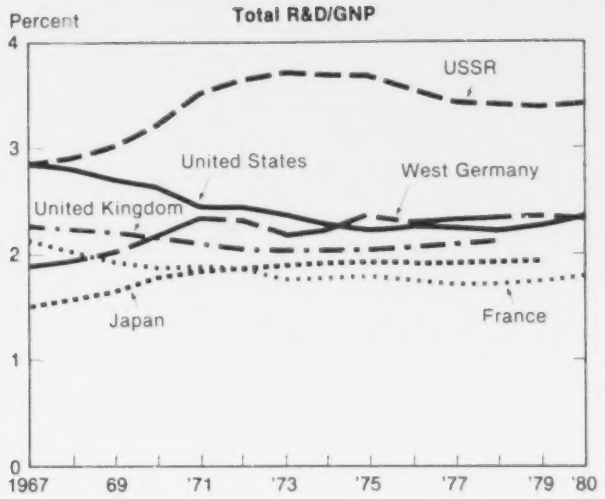
*Output per worker hour

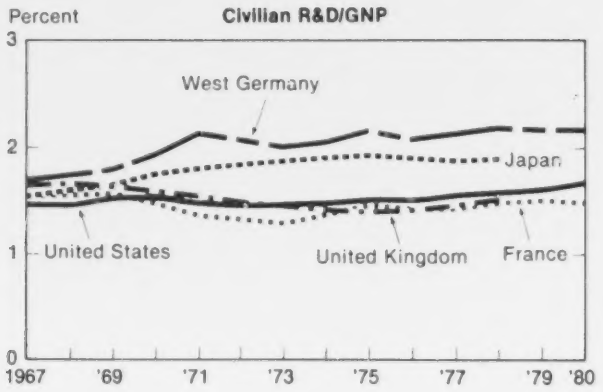
Source: National Science Board

- Although the productivity of the United States exceeded the rates for all of the countries compared until 1967 and four of the other five until 1970, the U.S. has had the lowest productivity rate since 1977.
- Over the last ten years, productivity in manufacturing industries has grown almost four times faster in Japan and twice as fast in France and Germany as in the U.S.

Exhibit 2

Research and Development Funding as Percent of Gross National Product, 1967-80





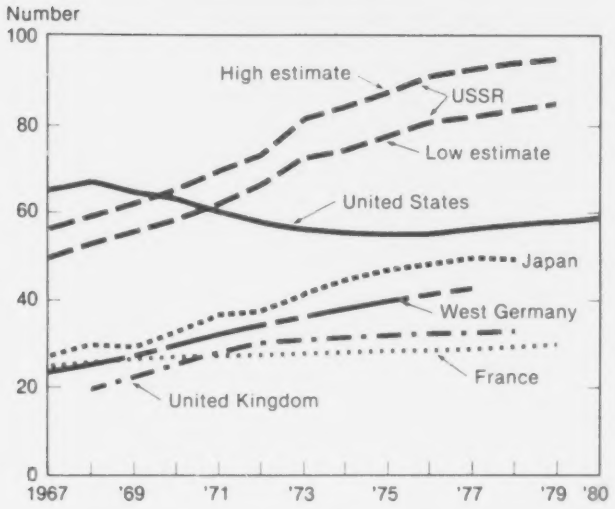
Source: National Science Foundation

- Over time, total research and development expenditures in the United States have declined as a proportion of total gross national product (GNP).
- In contrast, the U.S.S.R., West Germany, and Japan have increased their spending on research and development relative to their overall economies.
- Although the United Kingdom and France have experienced a decline in research and development, the U.S. decline is much greater than either of the two.
- When government funds for defense and space are excluded (civilian research and development), West Germany and Japan can be seen to expend a larger proportion of their respective GNPs on research and development.

Exhibit 3

Research and Development Scientists and Engineers as a Proportion of the Labor Force, 1967-80

International R&D scientists and engineers/10,000 labor force



Source: National Science Foundation

- Another means of comparing the relative emphasis that nations place on research and development is to contrast the concentration of scientists and engineers engaged in research and development in the labor force.
- The United States and the Soviet Union, with their greater emphasis on defense-related research and development, have a greater proportion of their labor force engaged in research and development activities than the other nations shown.
- There is considerable concern, however, that increased levels of defense spending in the U.S. will draw scientists and engineers away from domestic activities.

Exhibit 4

High-Technology and Energy-Related Manufacturing Employment in the United States, 1959-80

	Employment			
	1959	1965	1975	1980
High-Technology	2,713,289	3,003,972	3,205,627	4,065,066
Energy-Related	752,728	631,894	695,736	931,823
Total Manufacturing Employment	16,206,932	17,595,093	18,374,397	21,151,842
Total Employment	40,692,115	47,743,277	60,564,361	74,835,525

	Percent Change			
	1959-65	1965-75	1975-80	1959-80
High-Technology	11%	7%	27%	50%
Energy-Related	– 16%	10%	34%	24%
Total Manufacturing Employment	9%	4%	15%	31%
Total Employment	17%	27%	24%	84%

Source: U.S. Bureau of the Census

- High-technology industries accounted for 27 percent of the growth in manufacturing employment from 1959 to 1980 and now account for 19 percent of total U.S. manufacturing employment.
- Employment in high-technology industries grew by 50 percent from 1959 to 1980, compared with 31 percent for all manufacturing enterprises.

Exhibit 5

Rapid Growth Manufacturing Industries in the United States, 1972-78 (Actual) and 1979-85 (Projected)

Industry	Compounded Annual Average Percent	
	Actual 1972-78	Projected 1979-85
Semiconductors	19.	20.7
Optical Equipment	18.4	13.8
Electronics Computing Equipment	17.0	15.0
Tanks and Tank Components	15.7	15.7
Calculators and Accounting Machines	13.6	10.0
Process Control Instruments	11.0	12.9
Office Machines	9.7	15.0
Measuring and Controlling Devices	8.4	10.6
Environmental Controls	6.5	11.9
45 Fastest Growing Manufacturing Industries	9.6	6.9
U.S. Average All Manufacturing	3.2	N.A.

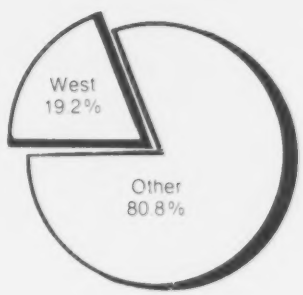
Note: Industries are ranked according to their 1972-78 growth rates determined by constant dollar value of shipments. N.A. = Not available

Source: U.S. Bureau of Industrial Economics

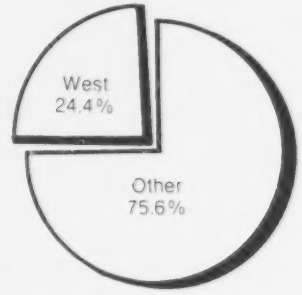
- All of the nine manufacturing industries projected to have the highest growth rates for the 1979-85 period are high technology.
- The nine industries had displayed 1972-78 growth rates two to six times faster than the U.S. average for all manufacturing industries.
- Private sector GNP average annual growth for the 1979-85 period is projected at 2.6 percent. No projection is available for growth in the U.S. average for all manufacturing.

Exhibit 6

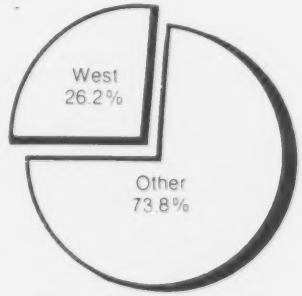
Proportion of High-Technology and Energy-Related Labor Force in the West, 1980



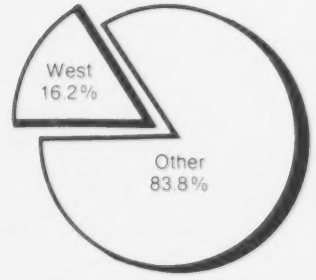
Total Labor Force



High Tech & Energy Labor Force



High Tech Labor Force



Energy Labor Force

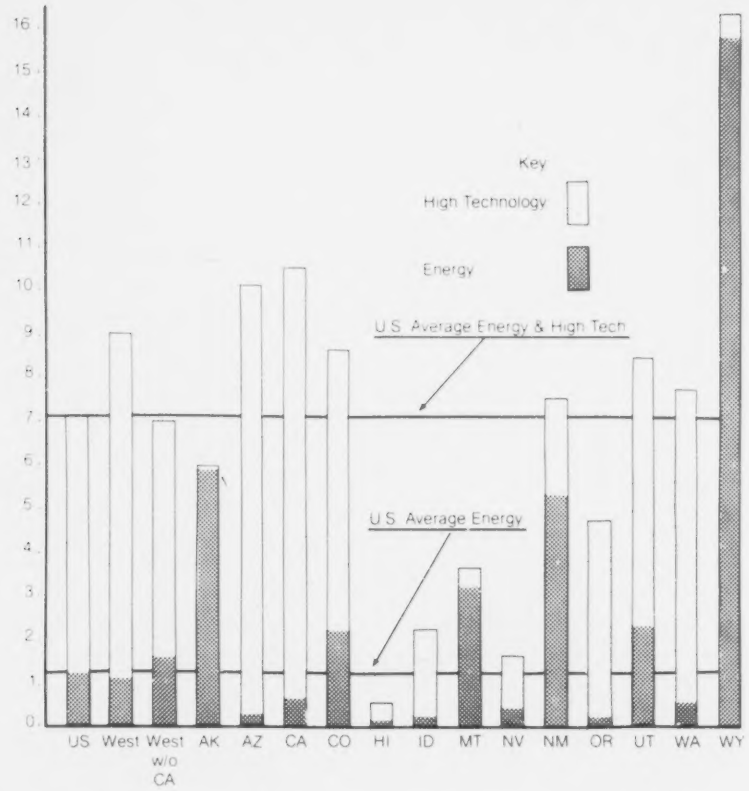
*The West consists of the following thirteen states: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, Washington, and Wyoming.

Source: U.S. Bureau of the Census

- Relative to the total civilian labor force, the West has a high proportion of workers in high-technology industries and in the combined high-technology and energy industries.

Exhibit 7

Percent of Work Force Engaged in Energy and High-Technology Industries in the West, 1980

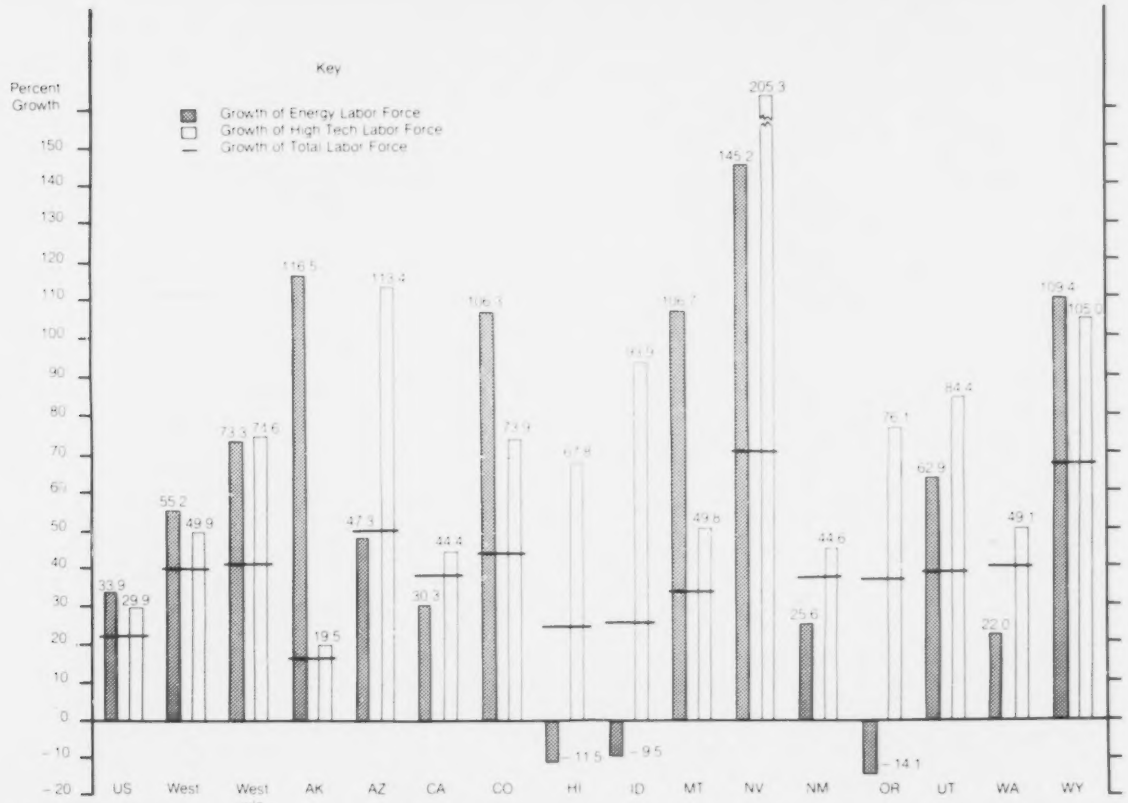


Source: U.S. Bureau of the Census

- The West has a higher concentration of employment in high-technology industries than the nation and a slightly lower concentration in energy-related industries (second column).
- When California is removed from these figures, the twelve remaining western states have a higher concentration of employment in energy-related industries and a lower concentration in high-technology industries than the nation (third column).
- Six states have larger percentages of their labor forces engaged in the energy industries than the national average (Alaska, Colorado, Montana, New Mexico, Utah, and Wyoming).
- Five states have larger percentages of their labor forces engaged in the high-technology industries than the national average (Arizona, California, Colorado, Utah, and Washington).
- Two states have larger percentages in both fields than the national averages (Colorado and Utah).

Exhibit 8

Percent Growth of Labor Force in Energy-Related and High-Technology Industries Compared with Overall Labor Force Growth, 1975-80



Source: U.S. Bureau of the Census

- In contrast to exhibit 7, which showed the relative concentration of employment, this figure depicts growth over the five most recent years for which data are available. Note that the very high growth rates in some states may be a function of their small absolute sizes in 1975.
- The region's growth rates for high-technology and energy industries have exceeded the national rates (first six columns). In addition, the total labor force in the West and in twelve of the states (excluding Alaska) exceeded the national rate of growth in the labor force.
- All thirteen states have growth rates in their high-technology labor force greater than the growth in the total labor force.
- Seven states had a greater growth rate in the energy industries than the national rate (Alaska, Arizona, Colorado, Montana, Nevada, Utah, and Wyoming).
- Twelve states have greater growth in the high-technology industries than the national rate (all except Alaska).

Exhibit 9

Proportional Growth of Energy and High-Technology Industries to the Growth of the Total Work Force in the U.S. and the West, 1975-80

	Energy-Related Work Force	High-Technology Work Force
United States	1.43	1.26
West	1.40 (a)	1.27
West without California	1.78	1.81
Alaska	7.14	1.19 (a)
Arizona	0.95 (a)	2.29
California	0.79 (a)	1.17 (a)
Colorado	2.42	1.73
Hawaii	(b)	2.82
Idaho	(b)	3.72
Montana	3.19	1.49
Nevada	2.03	2.87
New Mexico	0.67 (a)	1.18 (a)
Oregon	(b)	2.09
Utah	1.63	2.19
Washington	0.53 (a)	1.20 (a)
Wyoming	1.62	1.55

(a) The figure is lower than the corresponding proportion (in the same column) for the U.S.

(b) Size of the labor force decreased

Source: U.S. Bureau of the Census

- The numbers above express the growth of the high-technology and energy work forces in proportion to the growth rate of the total state or regional labor force. For example, the energy industry labor force in the U.S. grew 1.43 times as fast as the entire U.S. labor force from 1975 to 1980.
- Nine of the states show a greater proportional growth in the high-technology industries than in the U.S. (Arizona, Colorado, Hawaii, Idaho, Montana, Nevada, Oregon, Utah, and Wyoming).
- Six states show a greater proportional growth rate than the U.S. in the energy industries (Alaska, Colorado, Montana, Nevada, Utah, and Wyoming).
- Five states have a greater proportional growth rate in both areas (Colorado, Montana, Nevada, Utah, and Wyoming).

Exhibit 10

Top Three High-Technology and/or Energy Industries by Size of Labor Force, 1980

	1	2	3
Alaska	**oil & gas extraction**	pipelines (except gas)	gas production
Arizona	**electronic components**	**computing equipment**	measuring equipment*
California	aircraft	electronic components	communication equipment computing equipment measuring equipment* missiles
Colorado	**measuring equipment***	computing equipment	communications equipment
Hawaii	**computing/DP services**	petroleum refining	electronic/electric equipment
Idaho	computing equipment	ordnance	electronic components
Montana	**oil & gas extraction**	**coal mining**	petroleum refining
Nevada	measuring equipment*	communications equipment	oil & gas extraction
New Mexico	**oil & gas extraction**	communications equipment	aircraft coal mining gas production
Oregon	**measuring equipment***	electronic components	computing equipment
Utah	missiles	measuring equipment*	computing equipment communications equipment electronic components
Washington	**aircraft**	**computing/DP services**	measuring equipment*
Wyoming	**oil & gas extraction**	**coal mining**	petroleum refining

*measuring, controlling, analyzing, optical, and photographic equipment

Bold face entries indicate that this industry employs substantially greater numbers than the following entry.

Source: U.S. Bureau of the Census

Part II
Indicators of Demand and Supply

This section is divided into three parts: (1) indicators or projections of the demand for engineers and scientists, (2) the current supply of engineers and scientists, and (3) a comparison of these projections of supply and demand. These sections are intended to convey an understanding of the relationship of higher education and projected manpower demand and of the scope of high-technology and energy-related higher education in the West.

Exhibits 11 through 16 depict the results of several studies of projected demand for scientists and engineers in high-technology and energy-related industries. These projections are difficult to compare because they are based on different assumptions, methodologies, and data bases. Specifically, assumptions about the overall growth of the economy and of national economic policy set the stage for different outcomes. In addition, the projections reviewed here cover different periods of time.

Projections of demand produced by federal agencies tend to be conservative while those produced by industry appear to be robust. Several of the projections included here were produced by academic researchers and also appear to be relatively conservative. Inherent in all projections is the inability to predict the effects of national economic and defense policies and their impact on the fields in question, or on the employment decisions of individual engineers, scientists, and technicians. These exhibits represent the range of projections that are available to guide policy decisions.

Part II, Section 1
Demand for Engineers and Scientists

Exhibit 11

Projected Job Openings for Graduates of High-Technology and Energy-Related Fields, 1978-90

	Job Openings, 1978-90 (in thousands)			
		Alternative Projections		
	Base line Assumptions	Accelerated Defense Spending	Synthetic Fuels Programs	Balanced Federal Budget
Geological Scientists	22	22	23	22
Mathematicians	3	3	3	3
Computer Professionals				
Programmers	300	302	300	299
Systems Analysts	221	223	221	221
Other	28	29	28	28
Engineers				
Aeronautical	24	35	24	24
Chemical	22	22	22	21
Electrical	121	128	121	120
Mechanical	89	95	89	89
Mining	7	7	7	7
Petroleum	11	11	11	11

Source: National Science Foundation and U.S. Department of Education

- This table depicts projected job openings under several conditions. The base projections assume that economic conditions and federal policies anticipated in early 1980 would hold true through the 1980s, including the following:
  - —a decline in unemployment to 4.5 percent by 1990;
  - —an increase in productivity for 1985-90 of 2.4 percent above the current rate of growth.
- The second, third, and fourth columns show the enhancements to the base projection in the first column by adding several new assumptions:
  - —column 2: accelerated federal expenditures for defense;
  - —column 3: heavy expenditures for a large synthetic fuels program,
  - —column 4: a balanced federal budget beginning FY 1983.
- With the exception of accelerated defense spending, the alternative assumptions result in little change from the base line projections.
- These projections appear to understate future demand because they do not estimate adequately the numbers of engineers who leave their positions before retirement (transfer-out). The figures in exhibit 12 are higher for some fields because they include these estimates.

Exhibit 12

Employment for Engineers, Computer Scientists, Geologists 1978 (Actual) and 1990 (Projected)

(in thousands)

		Projected Job Openings 1990		
Occupation	Employed 1978	Low	High I	High II
Engineers (all fields)	1,071	433	553	460
Aero-astronautical	57	41	47	43
Chemical	53	15	20	17
Electrical	291	150	188	157
Mechanical	199	75	101	80
Geologists	33	17	20	18
Computer Specialists	389	349	404	365
Programmers	204	150	177	157
Systems analysts	185	199	227	207

Source: U.S. Bureau of Labor Statistics

- These projections are based on the following assumptions:
  - —reductions in personal and corporate taxes,
  - —investment stimulated by tax reductions,
  - —increased expenditure for new equipment by private sector,
  - —sharp increase in defense spending,
  - —cutbacks in importation of crude oil.
  - Low: —decline in rate of labor force expansion,
    —continued high inflation,
    —modest increases in production and productivity.
  - High I: —large increases in GNP,
    —increased labor force growth.
  - High II: —large increases in GNP,
    —increases in productivity.
- These projections, completed in mid-1981, show marked increases in the numbers of electrical engineers and aero-astronautical engineers needed compared with Exhibit 11. These increases result partly from figuring in prospective flows of experienced workers into and out of engineering positions.
- As with all national projections, these may not accurately reflect growth rates for individual states or regions.

Exhibit 13

Projected Need for New Engineers

	Historical Growth	Change from Historical Growth			
		−2%	−1%	+1%	+2%
Growth (Overall Projection)	205,100	−1,400	98,400	319,100	441,000
4.3% Replacement*	453,500	419,400	436,200	471,300	489,600
Total Requirement	658,600	418,000	534,600	790,400	930,600
Average Engineers/Year	82,300	52,300	66,800	98,800	116,300

*Number of engineers needed to replace those leaving the field.

Source: Landis and Svestka

- These projections examine the total numbers of engineers, irrespective of field, that will be required by U.S. industries. The projections are tied to the overall historical growth rate for the U.S. economy for the period 1963-76, which was 3.17 percent annually.
- The projections of demand for engineers in the four columns on the right are based on varying economic conditions that deviate from the historical rate of growth. Thus, if overall economic growth was 2 percent lower than the historical rate of 3.17 percent, then the figures in the column headed "−2%" would indicate the projected demand for engineers over the period 1979-87.
- In addition to the demand for engineers resulting from economic growth, the total requirement for engineers includes replacements for those who leave the profession. Note that the numbers of new engineers needed to replace current practitioners is greater than the number needed for expansion related to economic growth.
- Current economic growth is below the historical rate of 3.17 percent and was negative for part of the 1980-82 recession.

Exhibit 14

Demand for Engineers and Scientists in 1985 (Projected)
(in thousands)

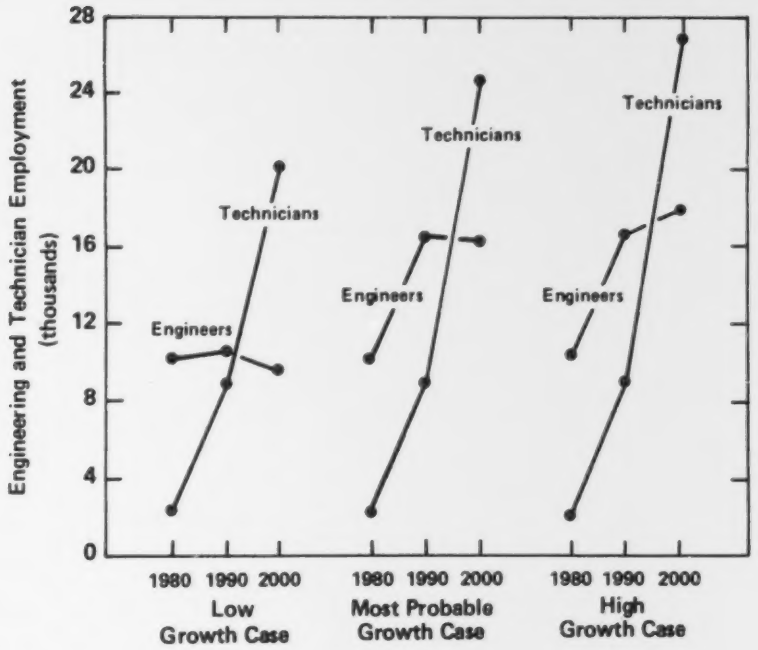
Occupation	Employed 1974	1985 Demand	Percent Growth
Engineers (all fields)	1,004.5	1,400.1	39.4
Chemical	49.0	69.0	40.9
Electrical	262.9	370.5	40.9
Mechanical	171.2	240.8	40.6
Aeronautical	44.2	49.2	10.9
Mining	4.7	6.5	39.7
Petroleum	11.8	18.9	60.0
Geological Scientists	24.5	32.0	30.7
Computer Specialists	268.1	398.0	48.4

Source: DauffenBach, Fiorito, and Folk

- This projection is based on a conceptual framework that analyzes three sources of workers (new entrants, experienced workers, and foreign workers) under several alternative scenarios that related the use of energy to the demand for engineers and scientists.
- Despite variations in assumptions among the three scenarios, the resulting projections revealed little variation in the requirements for most of these occupations.

Exhibit 15

Projected Employment of Technicians and Engineers in the Coal Mining Industry through the year 2000 for Three Coal Output Growth Levels

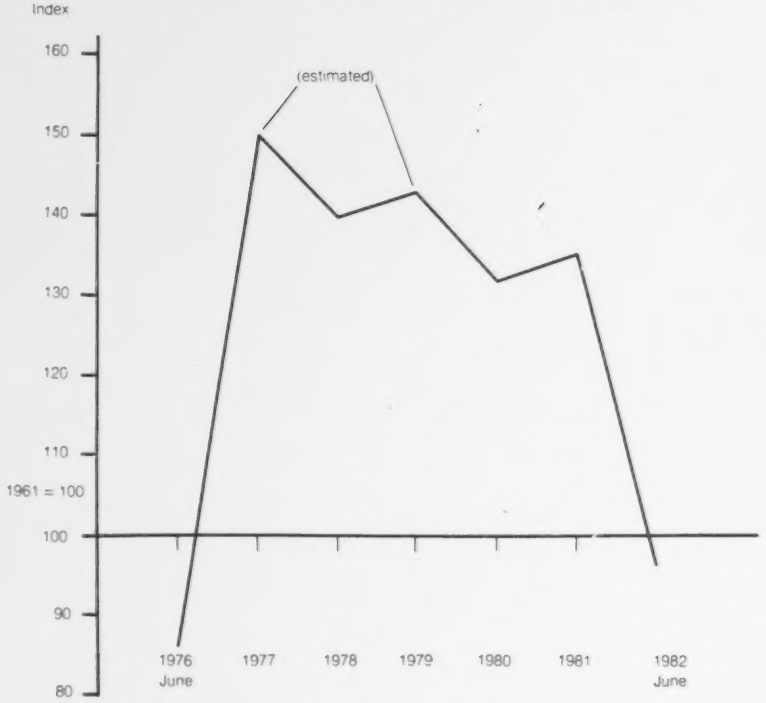


Source: Oak Ridge Associated Universities

- The low growth case for the year 2000 is based on a 4.2 percent yearly growth rate in coal output; the most probable, 5.4 percent; and the high, 6.2 percent.
- The demand for mining technicians, who usually have two-year degrees, will increase ten- to fifteen-fold from 1980 to 2000.
- This projection, prepared by the MITRE Corporation for the U.S. Department of Energy, is extremely complex and dependent upon previous estimates, with the result that small errors may cause very large errors in future projections.

Exhibit 16

High Technology Recruitment Index



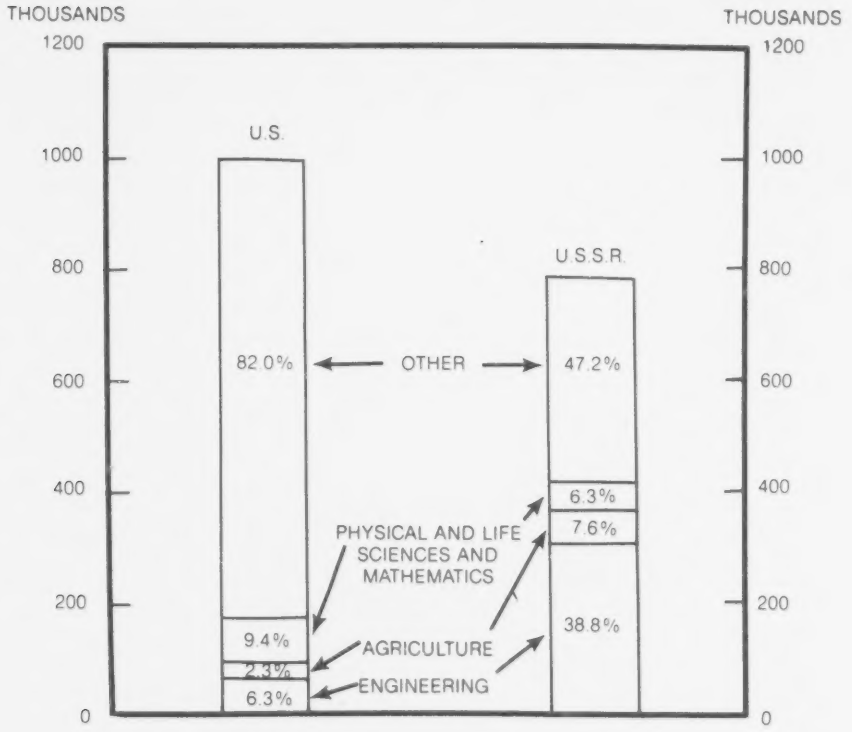
Source: Scientific Manpower Commission

- The High Technology Recruitment Index, which measures the volume of recruitment advertising directed towards engineers and scientists, reflects the rate of new business and operates as a leading indicator of economic developments.
- Demand for personnel in high-technology fields is subject to economic and political forces, which may cause short-run divergences from long-run trends or forecasts.
- As recruitment activities turn downward, spot shortages may become surpluses. However, long-range demand projections may still hold despite the current softness of the market.
- Educational programs must recognize that prolonged periods of downturn in industry recruitment activities will result in deterring students from enrolling in the engineering and scientific fields reflected by the index. Thus, program expansion should be considered carefully in fields where student demand is closely tied to their perceptions of short-run economic circumstances.

Part II, Section 2
Supply of Engineers and Scientists

Exhibit 17

U.S. Bachelor's Degrees and U.S.S.R. Diplomas Conferred by Major Field of Study, 1979

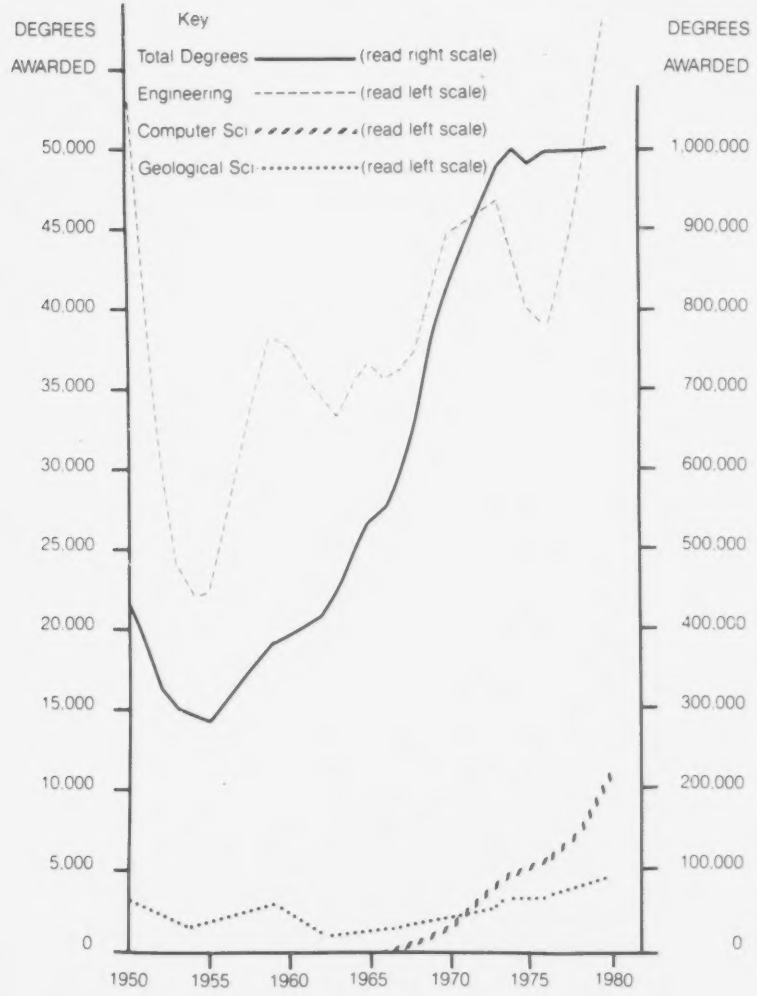


Source: National Science Board

- The supply of engineers is constrained by the structure and capacity of the system of higher education. As illustrated, the Soviet Union awards more degrees in engineering than the United States because its system of higher education is less diverse and more utilitarian than higher education in this country.
- Although the United States awarded over 27 percent more bachelor's degrees than the Soviets awarded diplomas, only about 18 percent of U.S. students received their degrees in science and engineering, compared with over 53 percent in the Soviet Union.
- Even more striking is the fact that in 1979 almost 39 percent of Soviet diplomas were in the field of engineering, compared with a little more than 6 percent in the United States.

Exhibit 18

Bachelor's Degrees in Engineering, Computer Science, and Geological Sciences Compared with Total Bachelor's Degrees, 1950-80



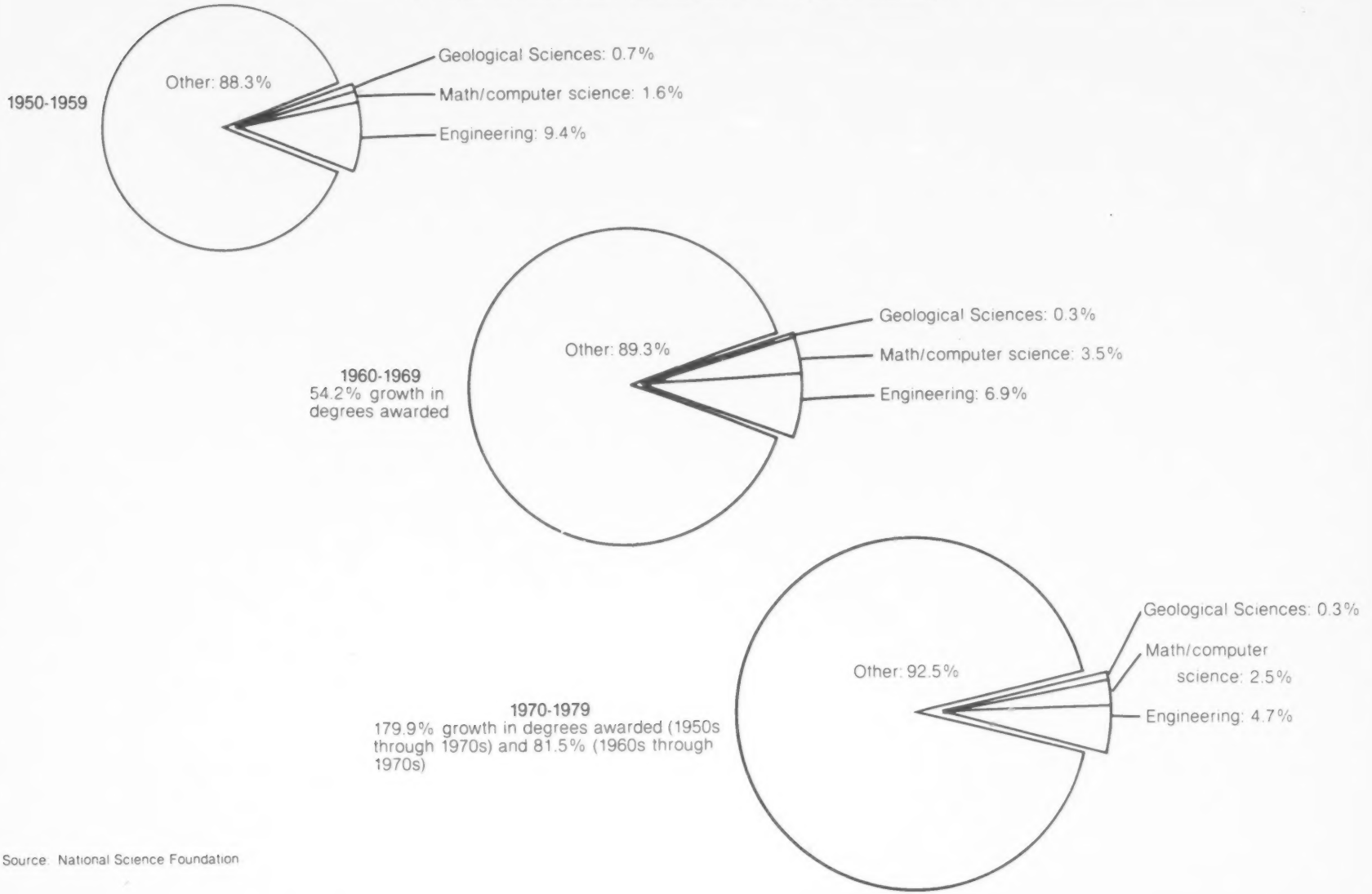
Source: National Science Foundation

- From 1960 to 1975 the growth in engineering bachelor's degrees was much slower than the growth of total degrees awarded.
- The rapid growth in engineering bachelor's degrees from 1975 to the present stands in contrast with the earlier up-and-down pattern.
- Since 1975, bachelor's degrees in computer science have increased more rapidly than total degrees awarded.
- The curve for engineering clearly shows the peaks and valleys of degree production over the last thirty years, in contrast to the much smoother curve for total degrees.
- Except for the 1965 trough in the geological sciences, the peaks and troughs in the curves all show a continuing growth pattern; that is, virtually all peaks and troughs are higher than preceeding peaks and troughs.

Exhibit 19

Bachelor's Degrees in Engineering, Mathematics and Computer Science, and Geological Sciences in Three Decades

(Figures Expressed as Percentages of all Degrees Awarded)

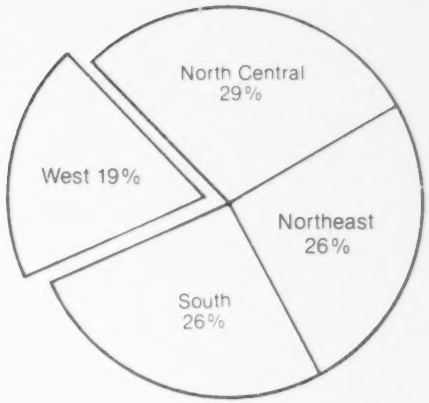


Source: National Science Foundation

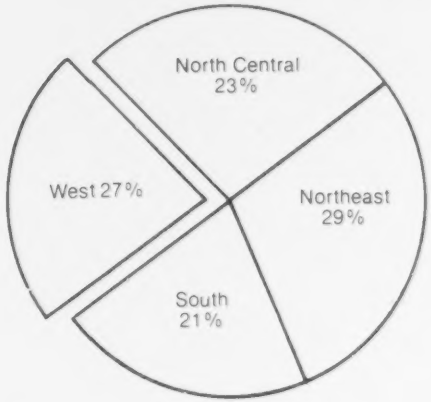
Exhibit 20

Proportion of Total Engineering Degrees in the United States by Region, 1980-81

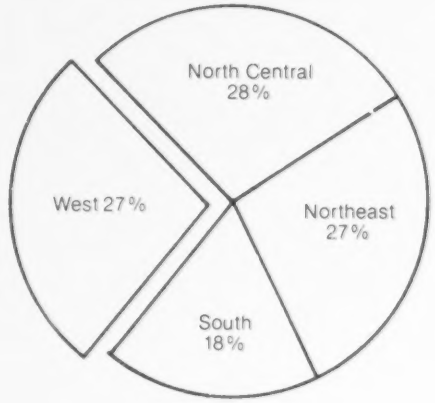
HIGH-TECHNOLOGY ENGINEERING



Bachelor's

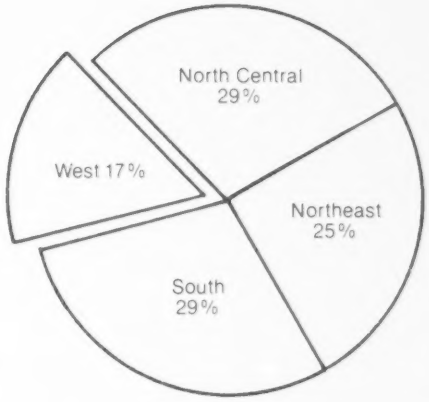


Master's

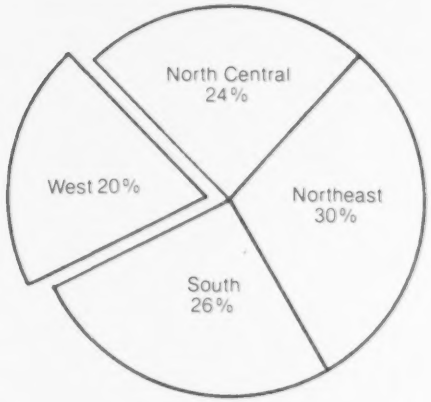


Doctorates

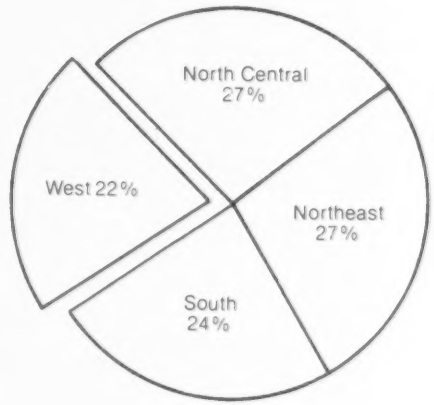
ENERGY-RELATED ENGINEERING



Bachelor's



Master's



Doctorates

Source: Engineering Manpower Commission

Exhibit 21

Degrees Awarded in Engineering, Computer Science, and Geological Sciences

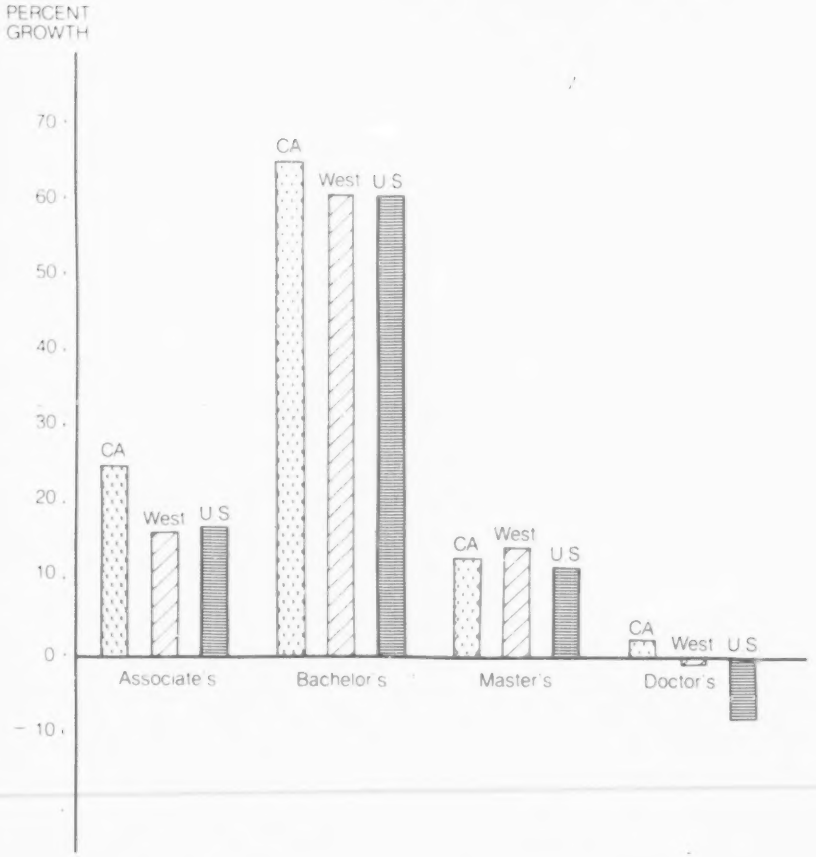
	West w/o Calif.	Calif.	Total West	U.S.	West as % of U.S.
High-Technology Engineering (1980-81) (Aerospace, bio-, computer, & electrical)					
Bachelor's	1,650	1,976	3,626	18,997	19.1%
Master's	428	1,052	1,480	5,720	25.9%
Doctorate	50	179	229	842	27.2%
Energy-related Engineering (1980-81) (Chemical, environmental, mechanical, mining, nuclear, petroleum)					
Bachelor's	2,428	1,498	3,926	23,102	17.0%
Master's	479	505	984	4,931	20.0%
Doctorate	91	102	193	870	22.2%
Computer Science (1979-80)					
Bachelor's	840	860	1,700	11,135	15.3%
Master's	187	502	689	3,545	19.4%
Doctorate	12	50	62	240	25.8%
Geological Science (1979-80) (Geology, geochemistry, geophysics, & seismology)					
Bachelor's	741	461	1,202	4,597	26.1%
Master's	304	124	428	1,295	33.1%
Doctorate	68	63	131	313	41.9%
All Fields (1979-80)					
Bachelor's	78,175	83,095	161,270	940,251	17.2%
Master's	23,584	31,133	54,717	299,095	18.3%
Doctorate	2,823	3,981	6,804	32,632	20.9%

Source: Engineering Manpower Commission and National Center for Education Statistics (see Appendix, tables A, B, C)

- Western colleges and universities award 17.2 percent of nationwide bachelor's degrees in all fields but 19.1 percent in high-technology engineering and 26.1 percent in geological sciences. In computer science the West's share is only 15.3 percent.
- As you go from bachelor's to master's and to doctorate degrees, the West's share increases. This pattern is pronounced in each of the three categories other than energy-related engineering.
- California accounts for well over one-half of the West's bachelor's degrees in all fields and in high-technology engineering and computer science, but only 38 percent in energy-related engineering and geological sciences. This pattern is more pronounced at the graduate level for all fields except for geological sciences.

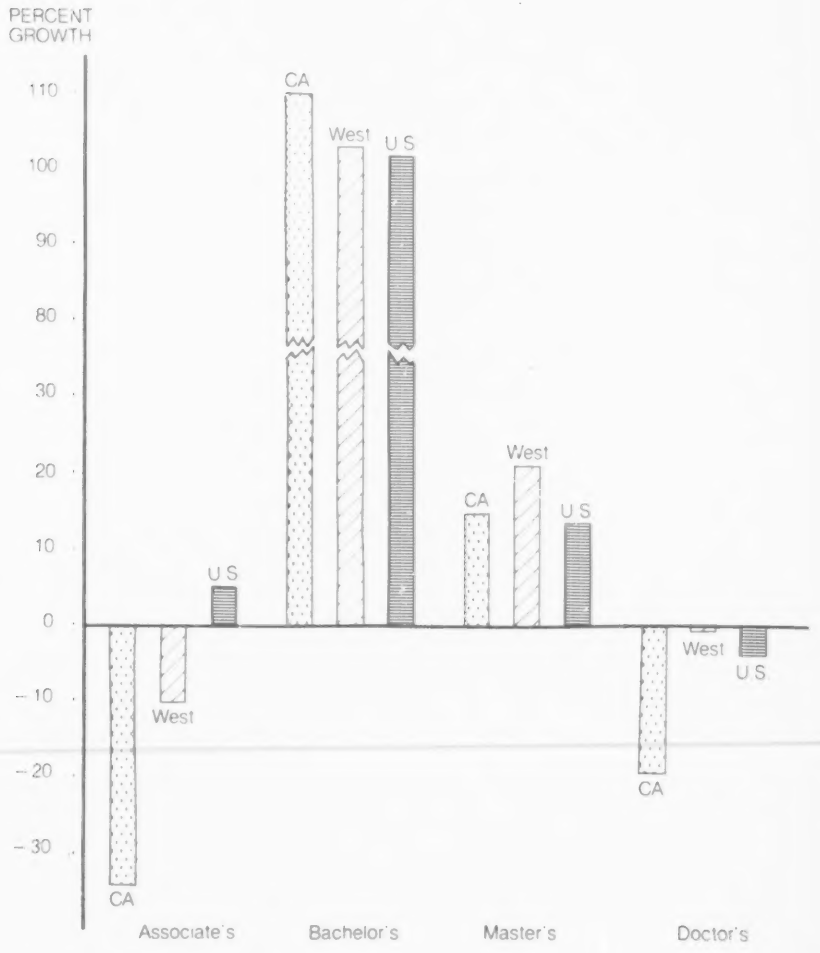
Exhibits 22-25 Percent Change in High-Technology and Energy-Related Degrees,

Exhibit 22: High-Technology Engineering



Source: Engineering Manpower Commission (see Appendix, tables E, G, I)

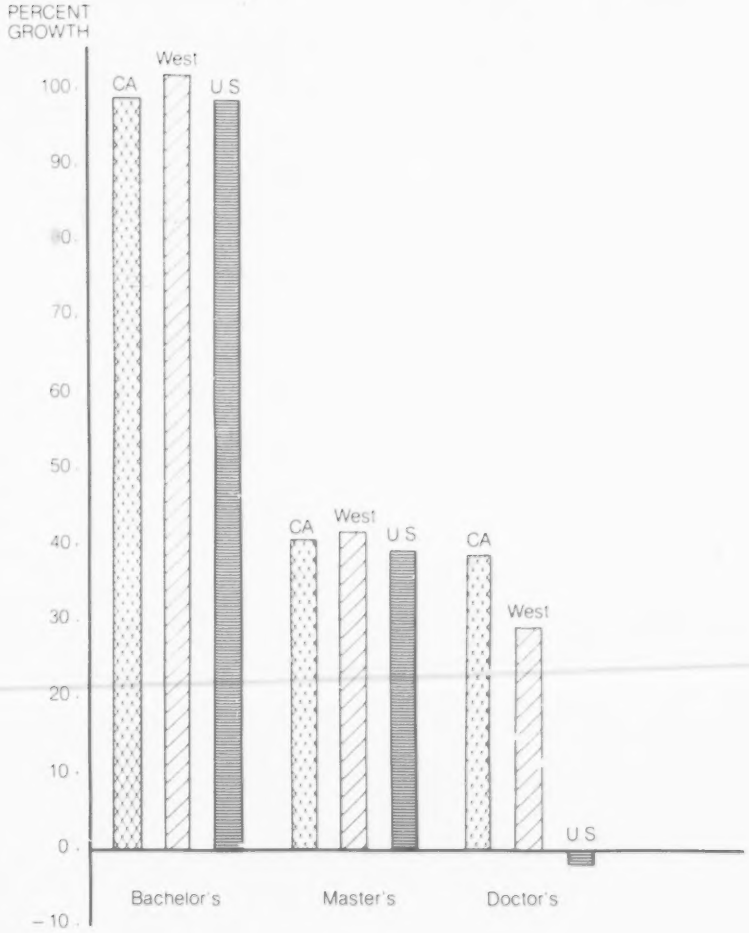
Exhibit 23: Energy-Related Engineering



Source: Engineering Manpower Commission (See Appendix, tables E, G, I)

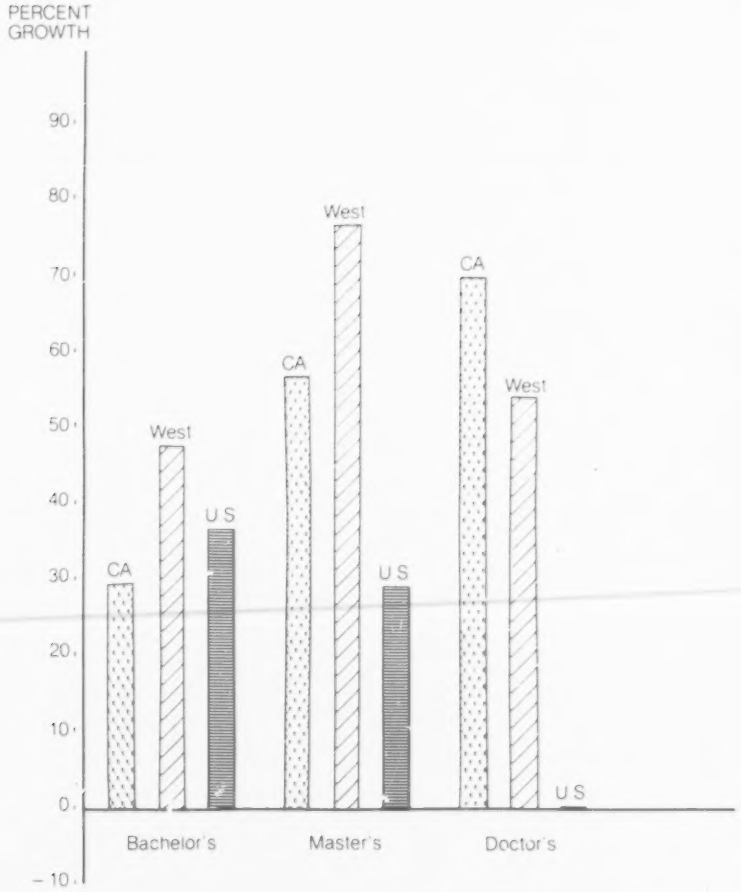
1975-76 through 1980-81: California, Whole West, United States

Exhibit 24: Computer Science



Source: National Center for Education Statistics (see Appendix, tables K, M, O)

Exhibit 25: Geological Sciences

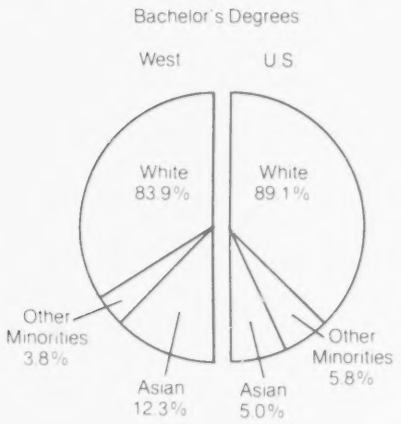


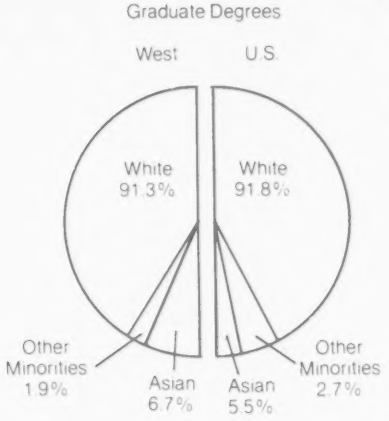
Source: National Center for Education Statistics (see Appendix, tables K, M, O)

Exhibit 26

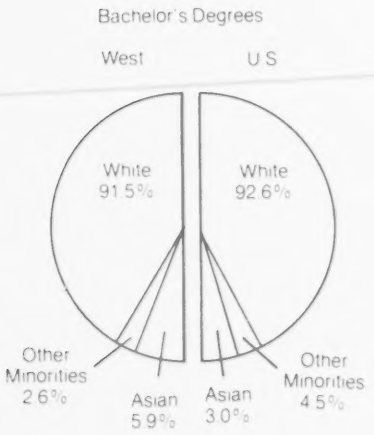
High-Technology and Energy-Related Engineering Degrees by Racial/Ethnic Category, 1980-81

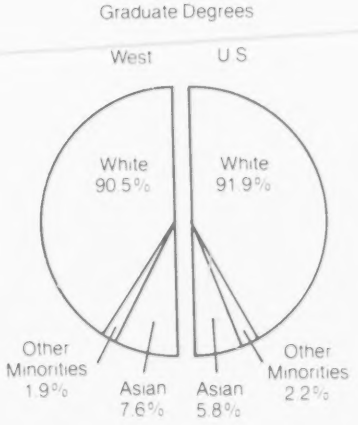
HIGH-TECHNOLOGY ENGINEERING





ENERGY-RELATED ENGINEERING





Percentages may not total 100 due to rounding.

Source: Engineering Manpower Commission (see exhibit 27)

- Minorities comprise a higher percentage of graduates in the West in high-technology and energy-related fields at both the bachelor's and graduate levels.
- Asian, Hispanic, and American Indian minorities make up a larger part of the population in the West than in other regions.
- The West has a lower concentration of blacks than the United States as a whole.

Exhibit 27

High-Technology and Energy-Related Engineering Degrees by Racial/Ethnic Category, 1980-81

Bachelor's Degrees

	Hispanic	Native American	Asian	Black	White	Total
HIGH TECHNOLOGY						
Rocky Mountain States	27 (2.6%)	3 (0.3%)	31 (3.0%)	4 (0.4%)	974 (93.7%)	1,039
Pacific States (exc. Calif.)	5 (0.8%)	2 (0.3%)	90 (14.7%)	3 (0.5%)	511 (83.6%)	611
California	70 (3.5%)	2 (0.1%)	325 (16.4%)	23 (1.2%)	1,556 (78.7%)	1,976
TOTAL WEST	102 (2.8%)	7 (0.2%)	446 (12.3%)	30 (0.8%)	3,041 (83.9%)	3,626
UNITED STATES	514 (2.7%)	26 (0.1%)	950 (5.0%)	573 (3.0%)	16,934 (89.1%)	18,997
ENERGY-RELATED						
Rocky Mountain States	29 (1.6%)	3 (0.2%)	20 (1.1%)	4 (0.2%)	1,707 (96.8%)	1,763
Pacific States (exc. Calif.)	3 (0.5%)	5 (0.8%)	71 (10.7%)	0	586 (88.1%)	665
California	47 (3.1%)	2 (0.1%)	140 (9.3%)	9 (0.6%)	1,300 (86.8%)	1,498
TOTAL WEST	79 (2.0%)	10 (0.3%)	231 (5.9%)	13 (0.3%)	3,593 (91.5%)	3,926
UNITED STATES	475 (2.1%)	37 (0.2%)	686 (3.0%)	503 (2.2%)	21,401 (92.6%)	23,102

Graduate Degrees

	Hispanic	Native American	Asian	Black	White	Total
HIGH TECHNOLOGY						
Rocky Mountain States	3 (0.9%)	0	10 (3.0%)	0	318 (96.1%)	331
Pacific States (exc. Calif.)	0	0	16 (10.9%)	0	131 (89.1%)	147
California	16 (1.3%)	0	89 (7.2%)	14 (1.1%)	1,112 (90.3%)	1,231
TOTAL WEST	19 (1.1%)	0	115 (6.7%)	14 (0.8%)	1,561 (91.3%)	1,709
UNITED STATES	82 (1.2%)	4 (0.1%)	358 (5.5%)	91 (1.4%)	6,027 (91.8%)	6,562
ENERGY-RELATED						
Rocky Mountain States	7 (1.5%)	0	8 (1.8%)	0	437 (96.7%)	452
Pacific States (exc. Calif.)	0	0	18 (15.3%)	2 (1.7%)	98 (83.1%)	118
California	12 (2.0%)	0	63 (10.4%)	2 (0.3%)	530 (87.3%)	607
TOTAL WEST	19 (1.6%)	0	89 (7.6%)	4 (0.3%)	1,065 (90.5%)	1,177
UNITED STATES	83 (1.4%)	2 (0.1%)	334 (5.8%)	49 (0.8%)	5,333 (91.9%)	5,801

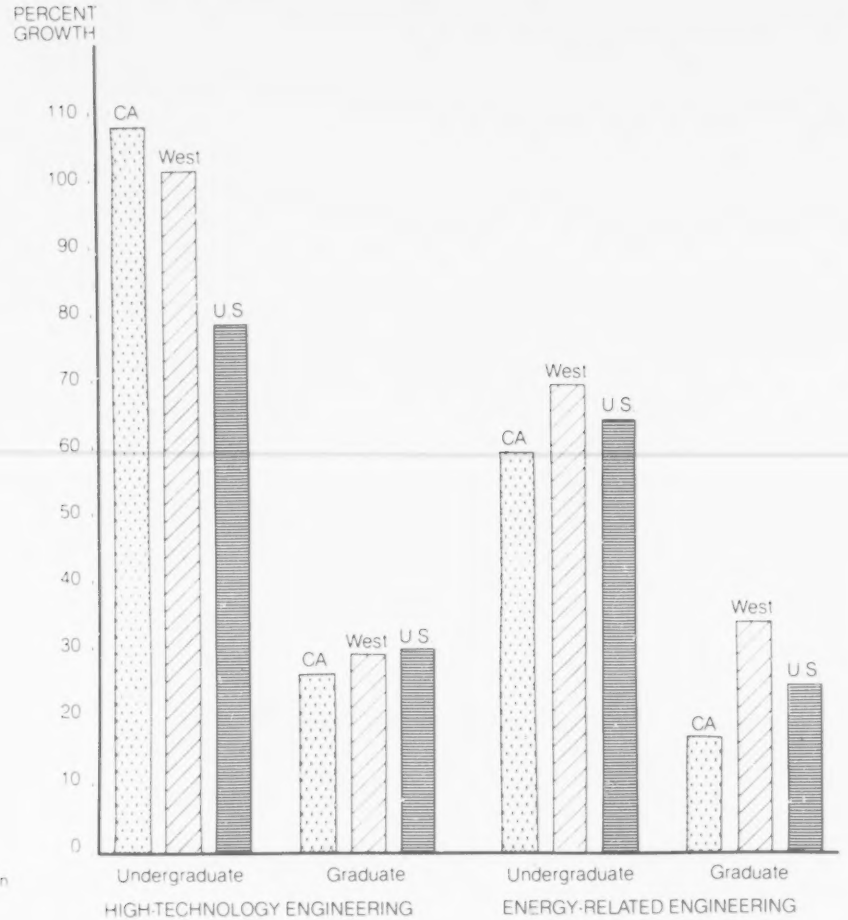
Percentages may not total 100 due to rounding.

Source: Engineering Manpower Commission.

- Minority students, except for Asians, earn a small percentage of engineering degrees in high-technology and energy-related fields.
- California institutions account for the largest share of degrees awarded to minorities in the West—an even larger proportion than their share of total degrees.

Exhibit 28

Percent Growth in Engineering Enrollments, 1976-81



Source: Engineering Manpower Commission (see Appendix, tables T & U)

- High-technology engineering undergraduate enrollment in California and the West more than doubled in five years, while the corresponding figure for the U.S. was an 80 percent increase.
- Undergraduate enrollment for energy-related engineering fields increased by nearly 70 percent in the West, by nearly 60 percent in California, and nearly 65 percent in the U.S.
- Graduate enrollment in both fields has grown at a slower pace than the undergraduate enrollments, but the growth rates are substantial, averaging around a 30 percent increase in five years.

Exhibit 29

Engineering Enrollments in the West, 1976-81

		1976	1977	1978	1979	1980	1981	Average Annual Percent Change
Undergraduate	HIGH-TECHNOLOGY ENGINEERING							
	Rocky Mountain States	4740	6036	6861	7692	9117	10485	24.2%
	Pacific States (exc. Calif.)	2268	2561	2611	2933	3130	3158	7.8%
	California	7013	7727	10134	11509	12799	14529	21.4%
	TOTAL WEST	14021	16324	19606	22134	25046	28172	20.2%
	UNITED STATES	73737	83328	93996	104808	120171	131005	15.5%
	WEST AS % OF U.S.	19.0%	19.6%	20.9%	21.1%	20.8%	21.5%	
	ENERGY-RELATED ENGINEERING							
	Rocky Mountain States	6606	8920	9407	9987	11207	11907	16.0%
	Pacific States (exc. Calif.)	1914	2307	2541	2759	2877	3010	11.5%
	California	5057	5411	6945	6920	7712	8057	11.9%
	TOTAL WEST	13577	16638	18893	19666	21796	22974	13.8%
	UNITED STATES	79512	91974	102110	110959	122228	130112	12.7%
	WEST AS % OF U.S.	17.1%	18.1%	18.5%	17.7%	17.8%	17.7%	
Graduate	HIGH-TECHNOLOGY ENGINEERING							
	Rocky Mountain States	1062	1243	1145	1091	1288	1536	8.9%
	Pacific States (exc. Calif.)	479	497	490	534	583	568	3.7%
	California	3581	4053	4376	3973	4234	4500	5.1%
	TOTAL WEST	5122	5793	6011	5598	6105	6604	5.8%
	UNITED STATES	20561	21523	21147	22577	24650	26655	5.9%
	WEST AS % OF U.S.	24.9%	26.9%	28.4%	24.8%	24.8%	24.8%	
	ENERGY-RELATED ENGINEERING							
	Rocky Mountain States	1030	1361	1350	1361	1674	1654	12.1%
	Pacific States (exc. Calif.)	372	367	391	374	457	481	5.9%
	California	1619	1822	1823	1804	1965	1902	3.5%
	TOTAL WEST	3021	3550	3564	3539	4096	4037	6.7%
	UNITED STATES	16670	17648	17013	18434	19824	20905	5.1%
	WEST AS % OF U.S.	18.1%	20.1%	20.9%	19.2%	20.7%	19.3%	

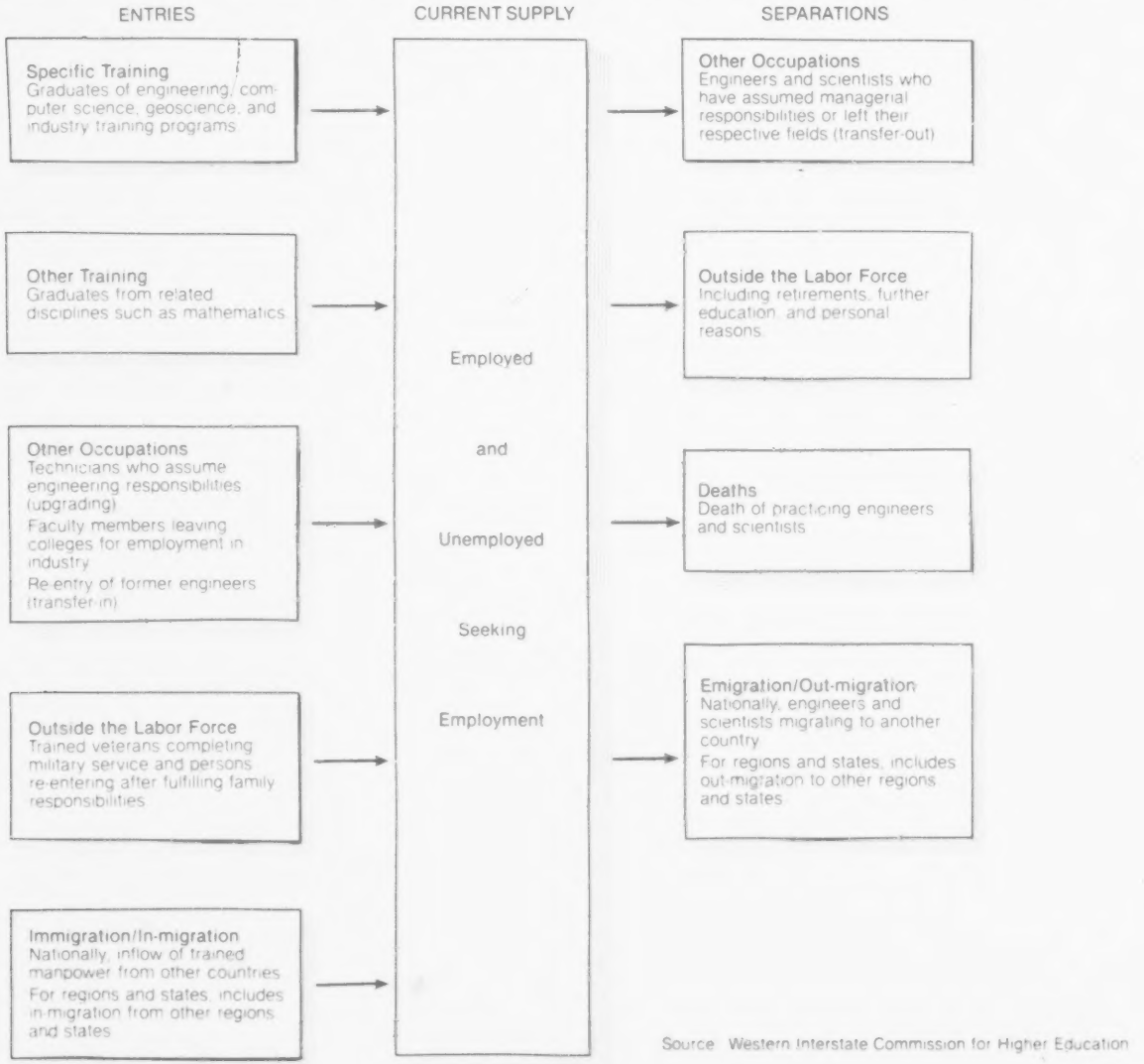
Source: Engineering Manpower Commission (see Appendix tables T, U)

- The West's share of high-technology bachelor's enrollments increased slightly over the period from 1976 to 1981, while the West's share of energy-related bachelor's enrollments remained relatively stable.
- The West's share of graduate enrollments in these fields showed slight variations. Although high-technology graduate enrollments in 1981 accounted for roughly the same proportion of total enrollments nationwide as in 1976, the proportion was lower than the percentage achieved in 1978. In contrast, energy-related engineering fields showed less variation in their proportion of national totals.
- The expected downturn in college enrollments, driven largely by demographic trends, may have an impact on engineering enrollments because there will be fewer traditional college-age students. Thus, there may be a shortage of qualified students to enter engineering programs.

Part II, Section 3
Comparison of Projected Demand and Supply of Engineers and Scientists

Exhibit 30

Flow of Workers into and out of High-Technology and Energy-Related Industries


ENTRIES
CURRENT SUPPLY
SEPARATIONS
Specific Training
Graduates of engineering, computer science, geoscience, and industry training programs
Other Training
Graduates from related disciplines such as mathematics
Other Occupations
Technicians who assume engineering responsibilities (upgrading)
Faculty members leaving colleges for employment in industry
Re-entry of former engineers (transfer-in)
Outside the Labor Force
Trained veterans completing military service and persons re-entering after fulfilling family responsibilities
Immigration/In-migration
Nationally, inflow of trained manpower from other countries
For regions and states, includes in-migration from other regions and states
Employed
and
Unemployed
Seeking
Employment
Other Occupations
Engineers and scientists who have assumed managerial responsibilities or left their respective fields (transfer-out)
Outside the Labor Force
Including retirements, further education, and personal reasons
Deaths
Death of practicing engineers and scientists
Emigration/Out-migration
Nationally, engineers and scientists migrating to another country
For regions and states, includes out-migration to other regions and states

Source: Western Interstate Commission for Higher Education

- This figure illustrates the general pattern of labor market supply in high-technology and energy-related industries.

Exhibit 31

Average Annual Engineering Manpower Supply and Demand (Projected, 1978-80)

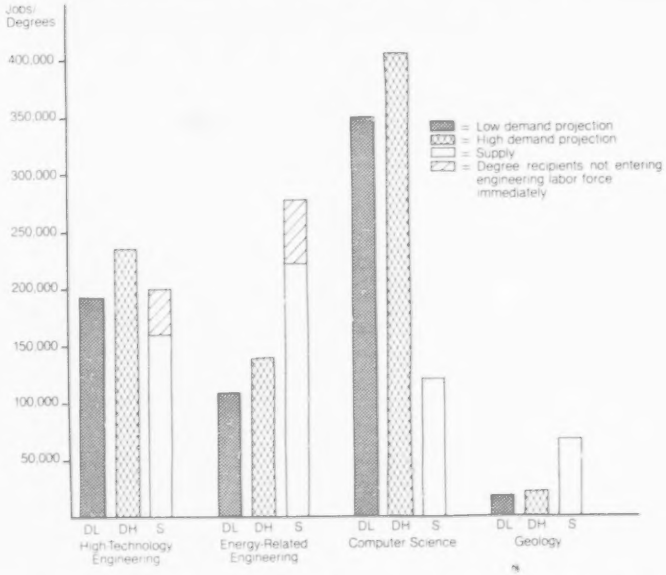
Average Annual Entry Supply		Average Annual Demand	
B.S. engineering degrees produced	68,100		
Less 20%	– 13,600		
Available to employment pool	54,500		
Immigrants entering engineering employment	5,000		
B.E.T. (engineering technology) degrees produced	10,900		
Less 20%	– 2,200		
Available to employment pool	8,700	36,100	Growth of engineering employment demand by expansion of economy
Employment of other new B.S. graduates	7,000	21,000	Replacement needs: death or retirement
Transfer back of engineers, upgrade of existing technicians, or nonengineer B.S. recipients	[29,500 (low) 38,200 (high)]	47,000 (low) 56,300 (high)	3.7% 4.3% Transfer out
Net Supply	**104,700 (low) 113,400 (high)**	**104,100 (low) 113,400 (high)**	**Net Demand**

Source: Adapted from Business-Higher Education Forum

- This exhibit depicts the projected average annual demand in engineering employment and supply available to meet that demand. It projects an approximate balance of supply to demand to 1990. (Also see exhibits 12, 13, 30.)
- Inherent in this projection is difficulty estimating the numbers of engineers who leave employment voluntarily ("transfers out") and those who eventually return ("transfers back"). The supply-demand balance would appear to be seriously jeopardized if the transfer-out rate approached 5-6 percent.
- The 20 percent reductions in engineering and engineering technology degree holders indicate those who do not go directly into the engineering labor force upon graduation. This figure could be conservative given the increasing enrollments of nonpermanent foreign nationals in U.S. engineering programs.
- U.S. Bureau of Labor Statistics data, used for part of this exhibit, do not include engineers employed in academic settings. In addition, the above data do not account for the supply of, and demand for, Ph.D. engineers.

Exhibit 32

Projected Job Openings and Degree Production in High-Technology and Energy-Related Fields, 1978-90



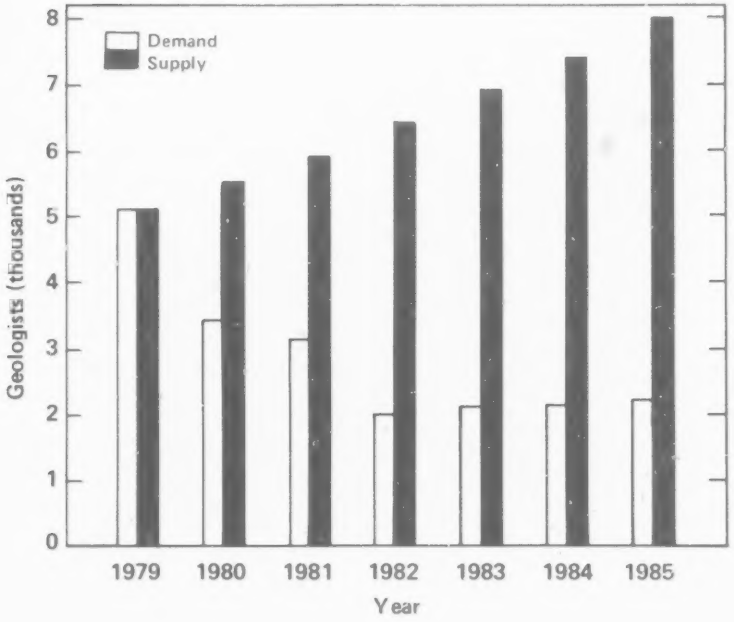
Sources: National Science Foundation and U.S. Department of Education; U.S. Bureau of Labor Statistics

- In this exhibit, high-technology engineering figures are derived from aeronautical/astronautical engineering and electrical engineering; the energy-related engineering figures are derived from chemical, mechanical, mining, and petroleum engineering.
- "DL" refers to the low projection for demand (job openings) as shown in exhibit 11 (for mining and petroleum engineering) and exhibit 12.
- "DH" refers to the High I projection for demand (job openings) as shown in exhibit 11 (for mining and petroleum engineering) and exhibit 12.
- "S" refers to supply—the projection of bachelor's degrees earned for the period 1978 through 1990. (Note: the projection for computer science, which is based on different material than the other projections, assumes that annual degree production will continue at the 1980 level.)
- Shaded areas in the supply bars for high-technology and energy-related engineering indicate the 20 percent of degree recipients who do not go directly into the engineering labor force immediately upon graduation (e.g., foreign nationals, recipients going directly to graduate school, recipients accepting non-engineering positions).

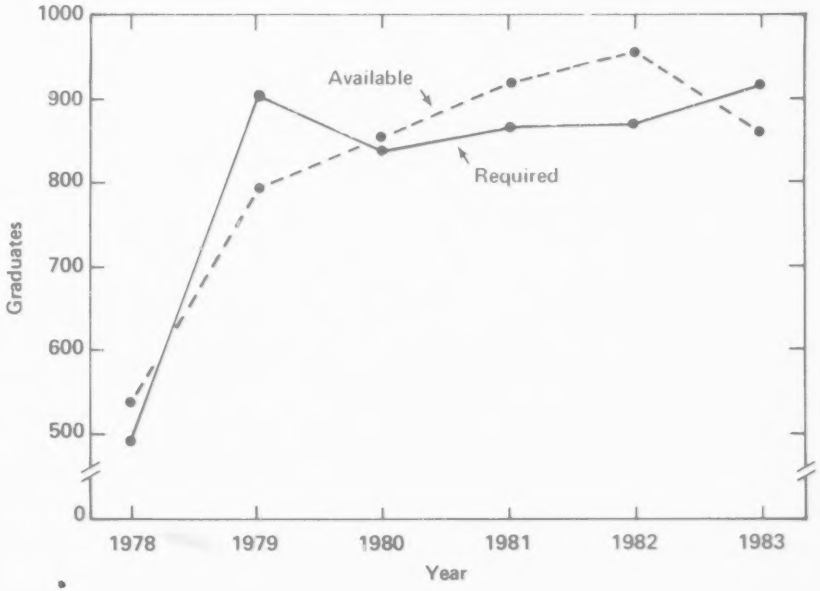
Exhibit 33

Projections of Annual Demand and Supply of Petroleum Geologists and Engineers

Estimated Supply Versus Estimated Demand for Petroleum Geologists (all degree levels) by Oil and Gas Companies, 1979-85

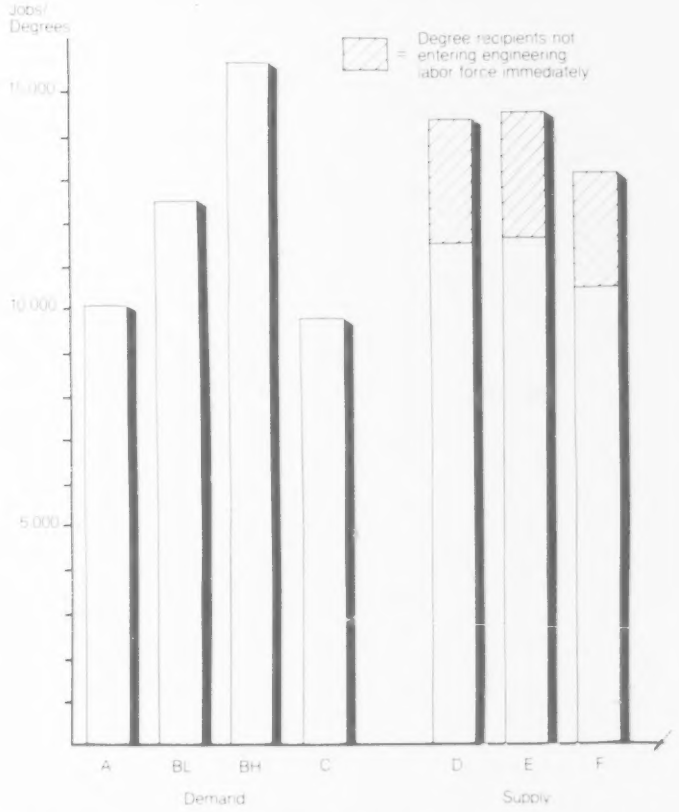


B.S./M.S. Petroleum Engineering Graduates Available and Required in U.S. Industry, 1978 and Projected 1979-83



Source: Oak Ridge Associated Universities

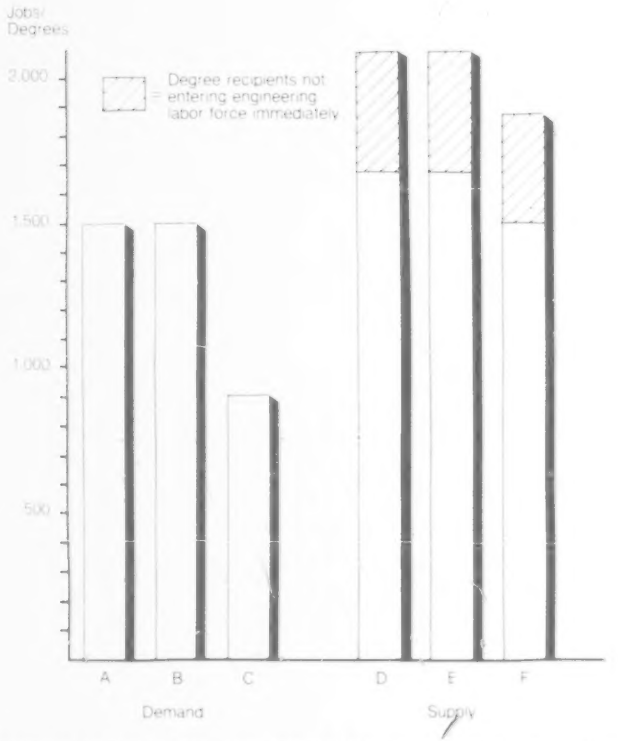
Exhibit 34: Electrical Engineers



Source: Engineering Manpower Commission; National Science Foundation and U.S. Department of Education; DauffenBach, Fiorito, and Folk; and U.S. Bureau of Labor Statistics (see exhibits 11, 12, 14 and Appendix, table A).

- Demand refers to the average annual number of job openings from 1978 to 1990.
- Supply refers to the average annual number of bachelor's degrees awarded from 1978 to 1990.
- Shaded areas indicate the 20 percent of engineering degree recipients who do not go directly into the engineering labor force (e.g., foreign nationals, graduate students, non-engineering positions).

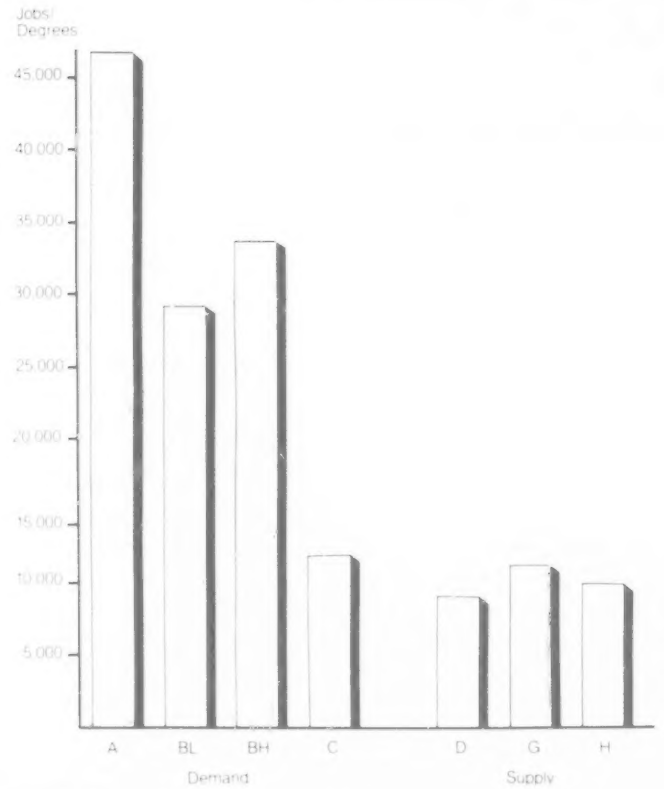
Exhibit 35: Mining and Petroleum Engineers



Source: Engineering Manpower Commission; National Center for Education Statistics; National Science Foundation and U.S. Department of Education; DauffenBach, Fiorito, and Folk (see exhibits 11, 14 and Appendix, table A).

- The projections of demand are derived from the following sources:
  - A. National Science Foundation and U.S. Department of Education
  - B. U.S. Bureau of Labor Statistics
  - BL. U.S. Bureau of Labor Statistics—Low Projection (see exhibit 12)
  - BH. U.S. Bureau of Labor Statistics—High I Projection (see exhibit 12)
  - C. DauffenBach, Fiorito, and Folk

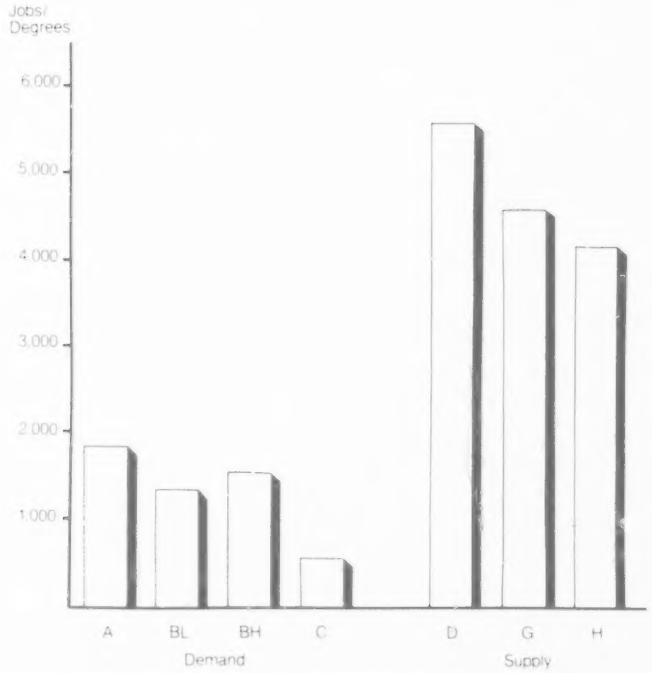
Exhibit 36: Computer Scientists



Source: Engineering Manpower Commission, National Center for Education Statistics, National Science Foundation and U.S. Department of Education, DauffenBach, Fiorito, and Folk, and U.S. Bureau of Labor Statistics (see exhibits 11, 12, 14 and Appendix, table A)

- The projections of supply are derived from the following sources:
  - D. National Science Foundation and U.S. Department of Education
  - E. Engineering Manpower Commission (assumes continuation to 1990 of the 1981 actual number of degrees granted)
  - F. Engineering Manpower Commision (assumes an annual average number of degrees granted equal to 90 percent of the 1981 figure in E)

Exhibit 37: Geological Scientists

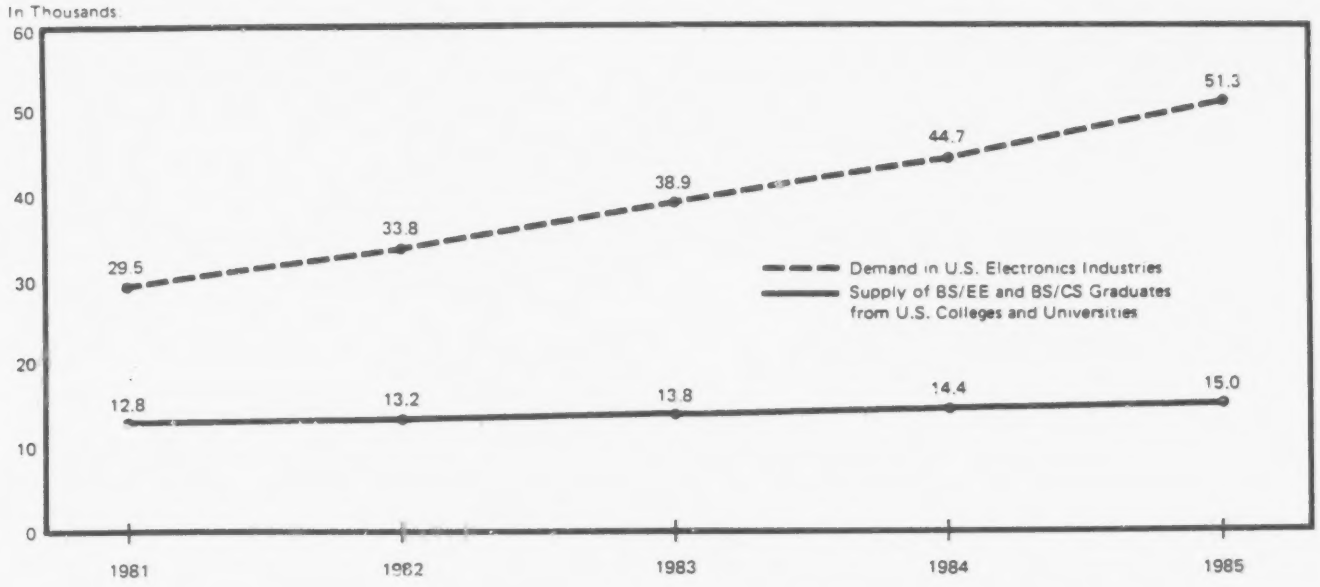


Source: Engineering Manpower Commission, National Science Foundation and U.S. Department of Education, DauffenBach, Fiorito, and Folk, and U.S. Bureau of Labor Statistics (see exhibits 11, 12, 14 and Appendix, table A)

- G. National Center for Education Statistics (assumes continuation to 1990 of the 1980 actual number of degrees granted)
- H. National Center for Education Statistics (assumes an annual average number of degrees granted equal to 90 percent of the 1980 figure in G)

Exhibit 38

Projected Supply and Demand for Electrical and Computer Engineers by U.S. Electronics Industries, 1981-85



Source: American Electronics Association

- The demand estimates were extrapolated by the American Electronics Association from survey results from respondents representing one-third of the industry's total sales and employment.
- These robust projections of demand may not have anticipated the general economic downturn in late 1981 and 1982 (see exhibit 16).

Part III
Problems Affecting Supply and Demand

This section presents data related to several problems affecting supply and demand, including:

- critical shortages of engineering and computer science faculty;
- salaries that are inadequate to attract engineers and computer scientists with advanced degrees into teaching;
- a high proportion of doctorates in engineering being awarded to foreign nationals, which further diminishes the pool of engineering doctorate recipients available to teach;
- inadequate equipment and facilities for teaching and research;
- underprepared students.

These issues are interrelated and ultimately influence both the quantity and quality of engineers and computer scientists available to high-technology and energy-related industries, which ultimately influences the growth and development of these sectors of the economy.

Perhaps the most serious problem is the immediate and continuing shortage of college faculty in computer science and engineering. The ability of programs to maintain enrollments rests on their ability to recruit and retain faculty. The anticipated increase in retirement rates coupled with existing unfilled faculty vacancies indicate that actions should be taken to deal with the long-run problem, as well as the short-run. This will require an expansion of graduate enrollment along with incentives to make teaching and academic research an attractive alternative to industrial employment.

Exhibit 39

National Engineering Faculty Positions in Selected Disciplines, Fall 1981

	Estimated Authorized Positions	% Unfilled Fall 1981	Approximate Number of Unfilled Positions	% of Fall 1981 Unfilled Since Fall 1980
Chemical	1,300	8.8	125	51.6
Civil	2,700	8.2	225	59.8
Electrical	3,900	8.5	355	57.3
Mechanical	3,100	8.9	285	51.9

Source: American Association of Engineering Societies and American Society for Engineering Education

- These figures indicate a continuing shortage of faculty in major engineering disciplines.
- A 1980 report by the American Council on Education (ACE) found that approximately 10 percent of all permanent, full-time faculty positions in engineering were vacant in fall 1980 and that approximately one-half of those had remained unfilled from the previous fall (1979).
- Of the seven fields covered by the ACE survey, the highest vacancy rate occurred in separate departments of computer science and computer engineering—16 percent. (Note that many institutions include computer engineering under electrical engineering and may also have separate computer science programs apart from engineering.)

Exhibit 40

Change in Ability of Colleges of Engineering to Recruit and Retain Faculty, Fall 1981

Ability to Recruit and Retain Faculty	Public Institutions	Private Institutions	All Institutions
Substantial Increase	4.1%	6.0%	5.3%
Slight/Moderate Increase	7.1%	16.4%	11.2%
No Change	6.1%	22.4%	12.4%
Slight/Moderate Decrease	38.8%	32.8%	37.1%
Substantial Decrease	43.9%	22.4%	34.1%

Source: American Association of Engineering Societies and American Society for Engineering Education

- Compared with fall 1980, a majority of the 197 institutions responding to this survey reported a decrease in their ability to recruit faculty in fall 1981.
- Public institutions experienced more difficulty than private institutions in recruiting and retaining faculty.

Exhibit 41

National Distribution of Engineering Faculty by Age for Selected Disciplines, Fall 1981

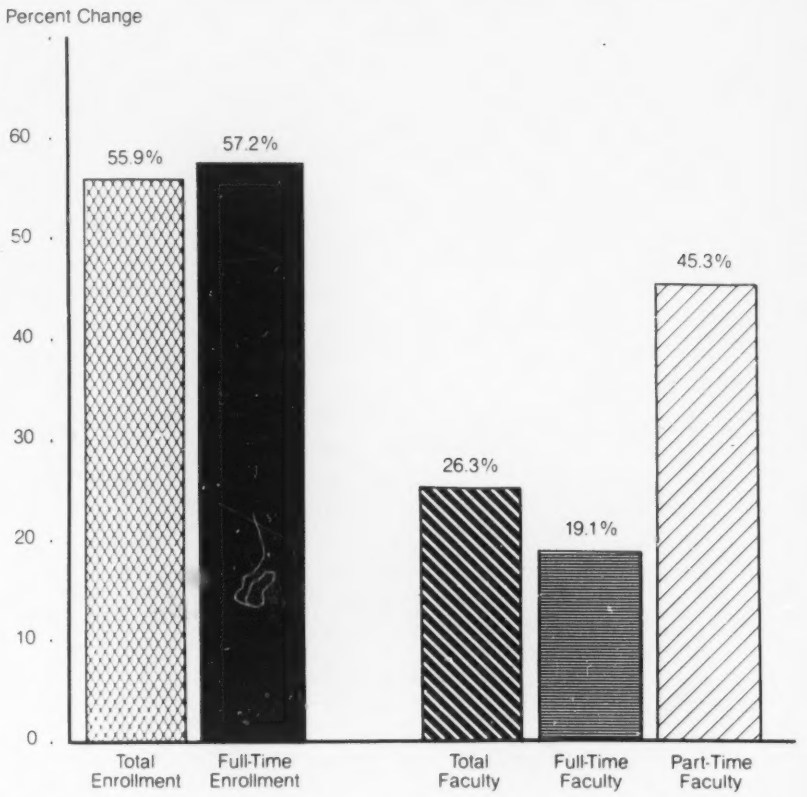
Age	Chemical	Electrical	Mechanical
70 +	1.7%	0.5%	0.4%
66-70	2.8%	1.8%	2.1%
56-65	16.6%	18.4%	22.1%
46-55	26.5%	28.8%	30.1%
36-45	28.6%	31.3%	27.9%
26-35	22.5%	18.7%	16.3%
25 or less	1.3%	0.4%	1.1%
Estimated Total Faculty	1,300	3,900	3,100

Source: American Association of Engineering Societies and American Society for Engineering Education

- Based on these data, the disciplines reported can expect approximately 20 percent of their faculty to retire within the next ten years.
- Data from several western states corroborate these national figures. For example, the California State University expects its retirement rate for engineering faculty to double between 1982 and 1986 and to more than double again between 1986 and 1990.
- These impending retirements will add to the current difficulties in recruiting faculty for authorized and unfilled positions.

Exhibit 42

Percent Change in Engineering Faculty and Enrollment in the West, 1976-81



Source: Engineering Manpower Commission and National Science Foundation (See exhibit 43).

- Enrollment in engineering in the West has grown more than two times faster than faculty size.
- The percentage growth in part-time faculty was far greater than the growth in full-time faculty, which suggests the difficulty of recruiting new faculty for authorized full-time positions.
- Nationally, total engineering faculty increased 23 percent compared to 26 percent in the West. Both full- and part-time faculty showed greater increases in the West than in the nation.

Exhibit 43

Engineering Faculty at Colleges and Universities in the West, 1976 and 1981

Total Engineering Faculty

	1976	1981	Difference	Percent Change
Mountain States	1,860	2,494	634	34.1
Pacific States	4,380	5,389	1,009	23.0
Total West	6,240	7,883	1,643	26.3
United States	28,296	34,789	6,493	22.9

Full-time Engineering Faculty

	1976	1981	Difference	Percent Change
Mountain States	1,589	2,107	518	32.6
Pacific States	2,928	3,273	345	11.8
Total West	4,517	5,380	863	19.1
United States	22,799	26,992	4,193	18.4

Part-time Engineering Faculty

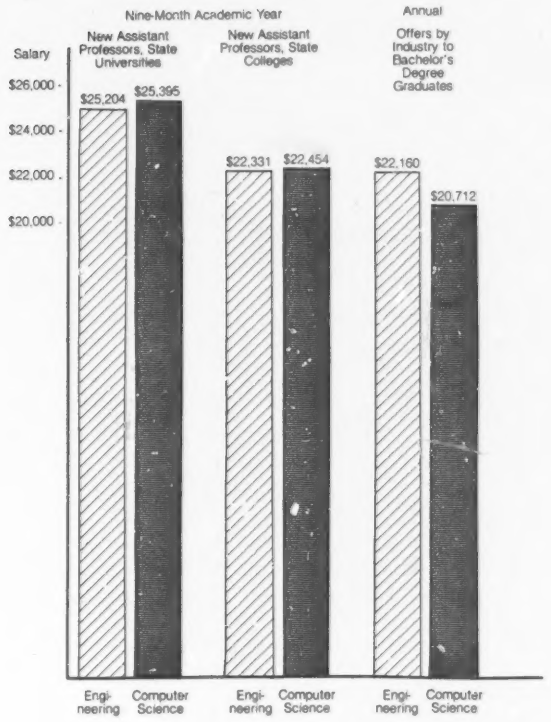
	1976	1981	Difference	Percent Change
Mountain States	271	387	116	42.8
Pacific States	1,452	2,116	664	45.7
Total West	1,723	2,503	780	45.3
United States	5,497	7,797	2,300	41.8

Source: National Science Foundation (see exhibit 42)

- From 1976 through 1981, the percentage of engineering faculty members in the West who were full-time dropped from 72 percent to 68 percent. Compared with the nation, the West has a smaller percentage of full-time faculty (68 percent in the West, 78 percent for the nation).
- Much of the increase in total faculty in the West is accounted for by a substantial increase in the employment of part-time faculty. This was especially the case in the Pacific states.

Exhibit 44

Salaries in Industry and Academe for New Hires, Fall 1981



Source: American Association of State Colleges and Universities/College and University Personnel Association; College Placement Council; Office of Institutional Research, Oklahoma State University (see exhibits 45, 46, 47, 48).

- Annual offers to recipients of bachelor's degrees are approaching starting salaries for newly employed college faculty, most of whom hold doctoral degrees requiring three or four years of study beyond the baccalaureate degree.
- Despite the academic attractions of a nine-month versus twelve-month employment period and the potential to earn outside income, there is a shortage of qualified students pursuing graduate study.
- Figures for salary offers by industry to bachelor's degree recipients in July 1982 were $25,260 for engineers and $22,896 for computer scientists. These salaries were close to those paid to new assistant professors at state colleges and universities. (Comparable 1982-83 faculty salaries were not available.)

- The faculty salaries shown in exhibit 46 are the arithmetic average based on a nine- or ten-month academic year. They do not include additional income (e.g., summer school teaching, consulting).
- Since it takes approximately three to four years of study beyond the baccalaureate degree for engineers to gain their doctorates and be ready to start as new assistant professors, the salaries for newly hired assistant professors should be compared to salaries of engineers with two to five years experience in exhibit 45. In all cases except mining, engineers in industry earn at least $2,000 more than their faculty counterparts.
- Based on experience and expertise, management-level engineers should be comparable to associate and full professors. The salaries paid full professors in aerospace engineering are fairly comparable with the managerial salaries, and the salaries for full professors in mining engineering are approximately $2,000 lower. For all other areas, however, there is at least a $5,000 difference between the salaries paid full professors and managerial level engineers. Associate professors earn, in almost all cases, at least $10,000 per year less than their managerial counterparts in industry.

Exhibit 45

Mean Salaries for Engineers in Industry, 1982

	Recent Graduates	2-5 Years Experience	Management Level
Aerospace	$21,016	$27,150	$39,167
Chemical	22,287	28,075	43,429
Electrical/Electronic	22,144	29,355	45,213
Energy	21,017	26,814	40,429
Mechanical	22,400	28,289	44,313
Mining	21,160	27,120	39,033
Petroleum	24,380	31,360	46,860

Source: Scientific Manpower Commission

Exhibit 46

Mean Salaries for Engineering and Computer Science Faculty at 70 State Universities and Land-Grant Colleges, 1981-82

	Full Professor	Associate Professor	Assistant Professor	Assistant Professor (New Hires)	Instructor	All Ranks
Aerospace	$39,093	$29,830	$25,111	$25,381	$14,367	$34,131
Bio-& Biomedical	38,160	30,536	24,578	23,000	—	32,289
Chemical	39,314	29,892	26,147	26,437	17,431	34,250
Computer Science	38,608	29,697	25,386	25,395	19,139	29,851
Electrical	37,781	29,630	25,883	25,720	18,128	32,742
Environmental	38,210	28,675	24,817	—	—	32,843
Mechanical	37,009	29,420	25,864	24,724	17,397	32,030
Mining/Mineral	36,936	29,751	27,935	27,000	16,789	32,595
Nuclear	38,268	30,375	26,410	—	—	34,351
Petroleum	40,143	34,871	28,710	28,767	18,171	36,525

Source: Office of Institutional Research, Oklahoma State University

Exhibit 47

Mean Salary Offers to New Degree Recipients, July 1982

	Bachelor's	Master's	Doctor's
Aeronautical Engineering	$23,676	$N/A	$N/A
Chemical Engineering	27,072	29,508	36,228
Computer Science	22,896	27,204	N/A
Electrical Engineering	24,768	28,428 (a)	37,188 (a)
Geological Engineering	27,036	N/A	N/A
Other Physical/Earth Science (b)	23,760	N/A	N/A
Geology/Geological Science	N/A	29,064	N/A
Mechanical Engineering	25,176	27,984	35,508
Mining Engineering	25,368	N/A	N/A
Nuclear Engineering (c)	24,468	27,600	N/A
Petroleum Engineering	30,468	N/A	N/A
All Engineering	25,260	28,298 (d)	36,308 (d)

(a) includes Computer Engineering
(b) includes bachelor's geologists
(c) includes Engineering Physics
(d) arithmetic average of offers listed in this column

N/A = not available

Source: College Placement Council

- The figures in exhibit 47 refer to the offers tendered to new hires from the graduating class of 1982. Since many degree recipients receive more than one offer, the total number of offers exceeds the total of new hires.
- The figures in exhibit 48 are medians, or mid-points, on a list of salaries paid to engineers in the selected fields and at various levels of educational preparation. (The median is often a better indicator of central tendency than the arithmetic average because the effects of very high and low figures are mitigated.)

Exhibit 48

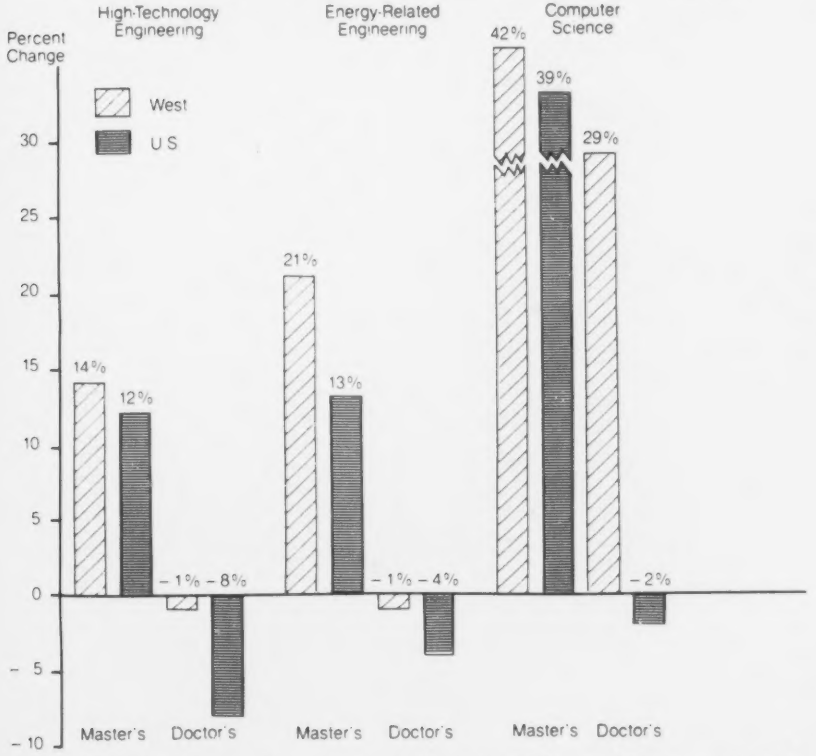
Median Salaries of Engineers in Industry, 1982

All engineers	$39,000
Chemical	42,894
Electrical	39,486
Mechanical	40,000
Nuclear	41,550
Petroleum/Mining	51,520
All fields, bachelor's degree holders	37,963
All fields, master's degree holders	40,000
All fields, doctor's degree holders	45,908

Source: National Society of Professional Engineers

Exhibit 49

Percent Change in Graduate Degrees in Engineering and Computer Science Awarded in the West (Engineering, 1976-81; Computer Science, 1976-80)



Source: Engineering Manpower Commission and National Center for Education Statistics (see Appendix, tables G, I, M, and O).

- The faculty shortage in engineering and computer science is partly a function of the decline in the numbers of students completing doctoral degrees, as well as an increase in the numbers of graduate engineers and computer scientists seeking employment in industry rather than academe.
- Some academic scientists and engineers are leaving colleges and universities for industry; these decisions are probably influenced by the salaries depicted in exhibits 45, 47, and 48.
- The West has increased its output of doctoral computer scientists by 29 percent from 1976 through 1980, while the nation's output has shrunk by 2 percent.

Exhibit 50

Percent of Doctoral Degree Recipients Who Are Foreign Nationals, 1976-81 (Selected Fields)

Year	Engineering	Math	Computer Science	Earth Science	Total Recipients in All Fields
1976	42.4%	23.7%	—	20.9%	15.2%
1977	41.6%	23.4%	—	17.7%	15.2%
1978	45.1%	24.1%	25.6%	14.4%	15.4%
1979	45.6%	26.0%	21.1%	16.3%	15.7%
1980	46.3%	27.1%	25.7%	16.9%	15.9%
1981	49.1%	31.5%	25.9%	17.2%	16.6%

Note: Statistics for computer science as a discrete category were not reported until 1978.

Source: National Research Council

- One-half of the doctoral degree recipients in engineering from U.S. universities in 1981 were foreign nationals, while, by comparison, the percentage of doctoral degree recipients in all fields in 1981 was 16.6.
- The percentages of foreign doctoral degree recipients in mathematics and computer science were also signficantly higher than for all doctoral degree recipients.
- These data include all foreign nationals, including those who are permanent residents of the United States. (Also see exhibit 51.)

Exhibit 51

Number and Percent of Engineering Degrees Awarded to Foreign Nationals, 1980-81

	Bachelor's		Master's		Doctoral	
	Number	Percent* of All Degrees	Number	Percent* of All Degrees	Number	Percent* of All Degrees
High Technology						
West	336	9.3	348	23.5	79	34.5
U.S.	1,538	8.1	1,289	22.5	288	34.2
Energy-Related						
West	300	7.6	275	27.9	74	38.3
U.S.	1,805	7.8	1,326	26.9	328	37.7

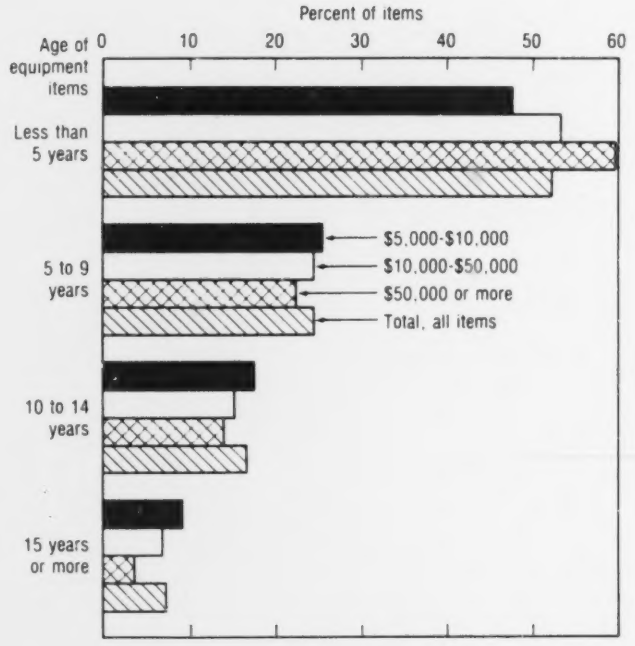
*Refers to the proportion of total degrees awarded in each area at the level indicated. For example, the 336 foreign nationals receiving bachelor's degrees in high-technology disciplines in the West equalled 9.3 percent of all high-technology bachelor's degree recipients in the West (see exhibit 21).

Source: Engineering Manpower Commission (see Appendix, table P).

- The proportion of engineering degrees awarded to foreign nationals increases as the degree level increases and is especially significant at the doctoral level.
- The proportion of doctoral degrees awarded to foreign students differs from exhibit 50 because of the definitions used in collecting the statistics. These data from the Engineering Manpower Council include only nonresident foreign nationals whereas the National Research Council (see exhibit 50) counts all foreign citizens whether or not they are permanent U.S. residents.

Exhibit 52

Age Distribution of Research Equipment in Selected Fields in 1981 by Cost Category



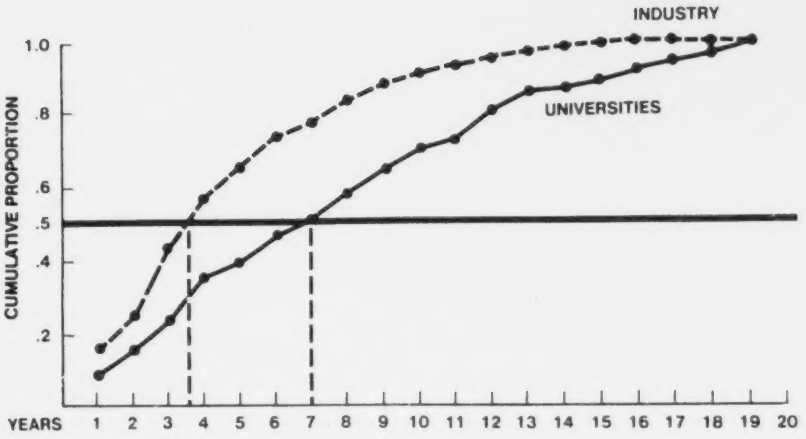
Note: Fields sampled include cell biology, organic chemistry, solid state physics, and electrical engineering.

Source: National Science Foundation

- The National Science Foundation gathered information on the age of research equipment from departments at a sample of thirty-eight institutions. Information on equipment used for instruction was not collected.
- About one-fourth of the research equipment in the four fields studied (cell biology, organic chemistry, solid state physics, electrical engineering) was older than ten years, another one-fourth was five-to-nine years old.
- Data (not shown) gathered by the study found that it was difficult for researchers to gain access to high cost and "state-of-the-art" equipment.

Exhibit 53

Proportion of Instrumentation Purchased Less Than "N" Years Ago by Industries and Research Universities

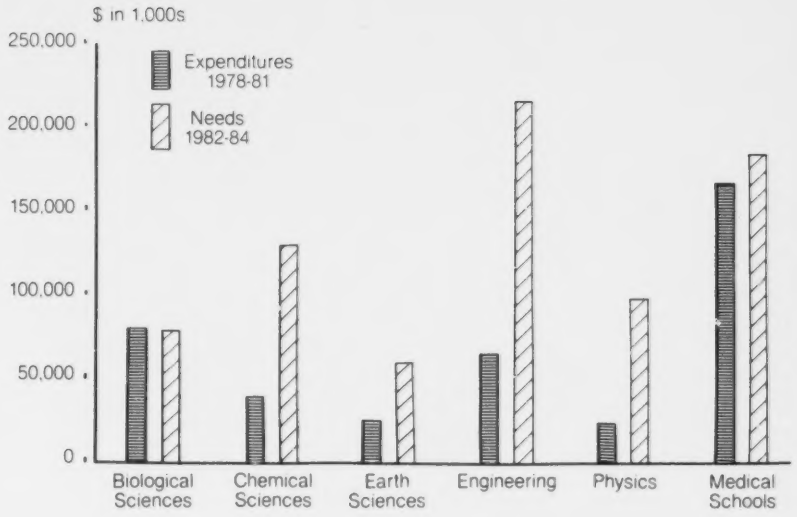


Source: Association of American Universities

- This exhibit compares the age distribution of the current inventories of university and industry instrumentation purchased between 1960 and 1978, based on a 1980 study of research universities and major industrial laboratories.
- The median age of instrumentation at the universities included in the study was roughly twice that of the instrumentation in the industrial laboratories (see vertical dotted lines).
- Data (not shown) indicate that instrumentation costs doubled between 1975 and 1979, while funds for new equipment lagged.

Exhibit 54

1978-81 Expenditures for New Facilities and Projected Needs for 1982-84 in Selected Fields



Source: Association of American Universities

- This study of fifteen research universities (only ten medical schools) revealed that engineering programs had the greatest projected needs for new facilities in the 1982-84 period.
- Construction of new facilities was ranked by the engineering schools as their greatest need, followed by modernization of existing structures (figures not shown).

Exhibit 55

Percent of High School Graduates Who Had Taken Various Mathematics and Science Courses, Spring 1980

Course	Total Percent	Male	Female	American Indian	Black	Hispanic	Asian	White
Algebra I	79.3	78.7	79.8	60.9	68.4	67.0	87.9	81.2
Geometry	56.2	58.0	54.6	34.3	37.9	38.5	78.8	59.5
Algebra II	49.0	51.3	47.0	31.8	39.0	37.6	75.6	50.4
Trigonometry	25.6	29.9	21.7	17.2	15.2	14.6	50.4	27.1
Calculus	7.8	9.8	6.0	5.1	4.5	4.2	22.1	8.2
Chemistry	37.3	39.2	35.4	23.9	28.2	25.6	58.8	38.8
Physics	19.4	25.7	13.6	17.1	18.6	14.9	34.9	19.5

Source: National Center for Education Statistics

- Relatively small percentages of spring 1980 high school graduates have taken courses in advanced mathematics and sciences.
- Relatively low percentages of American Indian, Black, and Hispanic students take any high school mathematics and science courses. Only about one-third of those students take any course beyond Algebra I.
- Strikingly higher percentages of students of Asian descent take mathematics and science courses, especially the more advanced sciences.
- Smaller percentages of female high school students take mathematics and science courses (except for Algebra I) than males.

Exhibit 56

Mean Scholastic Aptitude Test (SAT) and American College Test (ACT) Scores for College-Bound Seniors, 1967-82

	Scholastic Aptitude Test			American College Test
	Verbal*	Mathematics*	Combined*	Composite
1967	466	492	958	19.4
1968	466	492	958	19.0
1969	463	493	956	19.4
1970	460	488	948	19.5
1971	455	488	943	18.9
1972	453	484	937	18.8
1973	445	481	926	18.9
1974	444	480	924	18.7
1975	434	472	906	18.6
1976	431	472	903	18.3
1977	429	470	899	18.4
1978	429	468	897	18.5
1979	427	467	894	18.6
1980	424	466	890	18.5
1981	424	466	890	18.5
1982	426	467	893	18.4

*The averages for the SATs from 1967 through 1971 are estimates.

SAT scores range from 200-800
ACT scores range from 1-36

Source: American College Testing Program; College Entrance Examination Board

- The populations of college-bound students taking the ACTs and SATs are different. Students interested in private colleges in the Northeast and the Pacific Coast states, for example, are required to take the SAT. The ACT is the required examination for many colleges and universities in the West.
- While the ACT composite scores have shown an overall downward trend over the years, the year-to-year results have fluctuated between slight rises and falls. The SATs have shown a consistent annual decline through 1981. The 1982 combined scores for the SAT were the first actual increase in the period shown.

Information Sources

Part I—Importance of Science and Technology to the United States and the West

Exhibit

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DauffenBach, Robert C.; Fiorito, Jack; and Folk, Hugh. *A Study of Projected Supply/Demand Imbalances for Scientific and Engineering Personnel.* Washington, DC: U.S. Government Printing Office, 1981.

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Appendix Tables

Table

A-C Engineering Manpower Commission. *Engineering and Technology Degrees 1981*. New York, 1981.

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Appendix Tables

The statistical tabulations included in this appendix were derived from two sources. Engineering data on enrollments and degrees award were originally published by the Engineering Manpower Commission of the American Association of Engineering Societies. All computer science and geological sciences degree data were obtained from the National Center for Education Statistics (U.S. Department of Education).

Engineering Manpower Commission (EMC) The Engineering Manpower Commission surveys engineering schools annually to obtain information on engineering and technology enrollments and earned degrees granted. This report, however, excludes engineering technology from the tabulations presented for baccalaureate and higher degrees because the data are incomplete and not comparable across years. Detailed information is presented on the characteristics of engineering degrees awarded during the academic year 1980-81, and degree production trends from 1975-76 through 1980-81 are reviewed.

For summary purposes,the twenty-one curriculum groups listed in the EMC data have been divided into three subgroups: high-technology engineering, energy-related engineering, and other engineering. Engineering professional degrees have been combined with the master's degree data. Because of the small number of professional degrees and enrollments (less than 2 percent of western and U.S. master's in 1980-81), this change should have no major effect on the data.

The disciplines included in each of the twenty-one curriculum groups are noted below:

High Technology

- Aerospace—includes aerospace, aeronautical and astronautical engineering
- Bioengineering—includes bioengineering and biomedical engineering
- Computer—includes computer science or computer engineering and related fields
- Electrical—includes electrical, electronic, electrical power, communications, and electromechanical engineering

Energy-related

- Chemical—includes chemical engineering and related fields
- Environmental—includes environmental, sanitary, atmospheric sciences, and water resources engineering
- Mechanical—includes mechanical, automotive, and related engineering
- Mining—includes mining, mineral, and geological engineering
- Nuclear—includes nuclear engineering
- Petroleum—includes petroleum engineering

Other

- Agricultural—includes agricultural and forest engineering
- Architectural—includes architectural engineering
- Ceramic—includes ceramic engineering
- Civil—includes civil, construction, structural, transportation, and related engineering
- Engineering Science—includes engineering or applied science, mathematics, mechanics, or physics
- General—includes general, engineering economic systems, and interdisciplinary engineering
- Industrial—includes industrial, human factors, manufacturing and related engineering
- Marine—includes marine and ocean engineering, and naval architecture
- Materials Science—includes materials science or materials engineering, metallurgical, and welding engineering
- Systems—includes systems, operations research and systems science
- Other—includes other fields not included above

National Center for Education Statistics (NCES): All computer science and geological sciences earned degree data were collected by NCES through its annual Higher Education General Information Survey (HEGIS). The data were prepared for WICHE by the National Center for Higher Education Management Systems. The surveys conducted by EMC and NCES differ in several ways and statistics from the two data bases should not be combined. For example, the most current degree data available from NCES are for 1979-80, whereas the engineering data available from EMC are for 1980-81.

To simplify presentation of the data, the following geographic regions were used in some of the tables:

Rocky Mountain States: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming.

Pacific States (excluding California): Alaska, Hawaii, Oregon, and Washington.

California: California produces approximately one-half of all engineers in the West, more than one-half of all graduate degrees, and practically all of the engineering degrees granted by private colleges and universities. Therefore, California is treated separately in some tables. Data specific to other individual states will be provided by the WICHE staff on request.

TABLE A

BACHELOR'S DEGREES AWARDED
IN ENGINEERING, COMPUTER SCIENCE, AND GEOLOGICAL SCIENCES
IN THE WEST AND THE U.S.

	AK	AZ	CA	CO	HI	ID	MT	NV	NM	OR	UT	WA	WY	TOTAL WEST	U.S.	WEST AS % OF U.S.	FED* CONT'L (WEST)
ENGINEERING (1980-81)																	
Aerospace	0	31	112	29	0	0	0	0	0	0	0	64	0	236	1587	14.9%	92
Bioengineering	0	2	41	6	0	0	0	0	5	0	0	0	2	56	496	11.3%	0
Computer	0	17	523	44	0	0	0	0	6	2	51	0	0	643	2356	27.3%	0
Electrical	11	210	1300	184	72	43	53	19	143	187	165	275	29	2691	14558	18.5%	75
HIGH TECHNOLOGY	11	260	1976	263	72	43	53	19	154	189	216	339	31	3626	18997	19.1%	167
Chemical	0	89	385	162	0	18	53	0	49	53	73	95	15	992	6863	14.5%	0
Environmental	0	0	48	0	0	0	9	0	3	0	0	0	0	60	248	24.2%	0
Mechanical	3	168	1020	176	39	16	39	16	111	116	142	328	25	2199	13462	16.3%	3
Mining	8	46	3	208	0	18	49	9	29	0	39	0	0	409	1054	38.8%	0
Nuclear	0	26	19	0	0	0	0	0	1	23	0	0	0	69	444	15.5%	0
Petroleum	0	0	23	59	0	0	35	0	35	0	0	0	45	197	1031	19.1%	0
ENERGY-RELATED	11	329	1498	605	39	52	185	25	228	192	254	423	85	3926	23102	17.0%	3
Agricultural	0	7	35	11	0	7	7	0	3	5	0	11	5	91	666	13.7%	0
Architectural	0	0	46	56	0	0	0	0	0	0	0	101	9	212	474	44.7%	0
Ceramic	0	0	0	0	0	0	0	0	0	0	0	17	0	17	291	5.8%	0
Civil	16	147	954	247	69	43	65	35	105	157	183	216	36	2273	10547	21.6%	58
Engineering Science	0	15	192	33	0	0	10	1	0	4	0	10	0	265	1067	24.8%	95
General	0	0	689	8	0	19	0	12	0	11	0	54	0	793	2169	36.6%	42
Industrial	0	45	204	0	0	0	15	0	15	46	6	41	0	372	3225	11.5%	0
Marine	0	0	8	0	0	0	0	0	0	0	0	0	0	8	854	.9%	0
Materials Science	0	19	47	32	0	6	8	3	13	0	13	35	0	176	1081	16.3%	0
Systems	0	16	11	4	0	0	0	0	0	0	0	0	0	31	235	13.2%	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	227	0	0
OTHER ENGINEERING	16	249	2186	391	69	75	105	51	126	223	202	485	50	4238	20836	20.3%	195
TOTAL ENGINEERING	38	838	5660	1259	180	170	343	95	518	604	672	1247	166	11790	62935	18.7%	365
COMPUTER SCIENCE (1979-80)																	
Comp & Info Science	0	69	698	98	56	9	30	0	60	105	116	85	6	1332	9159	14.5%	0
Info Sci & Systems	0	61	81	53	17	5	0	2	0	8	0	3	7	237	1210	19.6%	0
Data Processing	0	17	0	0	0	0	0	0	7	0	26	0	0	50	580	8.6%	0
Computer Programming	0	0	81	0	0	0	0	0	0	0	0	0	0	81	148	54.7%	0
Systems Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	0
TOTAL COMP SCIENCE	0	147	860	151	73	14	30	2	67	113	142	88	13	1700	11135	15.3%	0
GEOLOGICAL SCIENCES (1979-80)																	
Geology	4	74	436	192	0	52	49	0	55	62	78	113	35	1150	4439	25.9%	0
Geochemistry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
Geophysics & Seismol	0	0	25	0	0	3	0	0	7	0	12	5	0	52	154	33.8%	0
TOTAL GEOL SCIENCE	4	74	461	192	0	55	49	0	62	62	90	118	35	1202	4597	26.1%	0

*Federal Control. These institutions are the Naval Postgraduate School in California and the United States Air Force Academy in Colorado. The Naval Postgraduate School awarded mostly master's degrees in 1980-81 and the Academy confers only bachelor's degrees.

Source: Engineering Manpower Commission and National Center for Education Statistics.

TABLE B

MASTER'S DEGREES AWARDED
IN ENGINEERING, COMPUTER SCIENCE, AND GEOLOGICAL SCIENCES
IN THE WEST AND THE U.S.

	AK	AZ	CA	CO	HI	ID	MT	NV	NM	OR	UT	WA	WY	TOTAL WEST	U.S.	WEST AS % OF U.S.	FED* CONT'L (WEST)
ENGINEERING (1980-81)																	
Aerospace	0	5	52	5	0	0	0	0	0	0	0	16	0	78	390	20.0%	21
Bioengineering	0	0	13	0	0	0	0	0	0	0	6	0	1	20	184	10.9%	0
Computer	0	0	333	33	0	0	0	0	0	0	18	0	0	384	1301	29.5%	0
Electrical	0	45	654	69	11	6	6	6	49	36	39	71	6	998	3845	26.0%	94
HIGH TECHNOLOGY	0	50	1052	107	11	6	6	6	49	36	63	87	7	1480	5720	25.9%	115
Chemical	0	10	87	35	0	7	3	0	18	9	19	19	3	210	1326	15.8%	0
Environmental	1	0	25	14	0	0	3	0	0	0	10	6	7	66	487	13.6%	0
Mechanical	0	23	344	14	9	9	4	0	33	19	32	24	6	517	2495	20.7%	44
Mining	1	16	0	49	0	6	1	4	2	0	6	0	0	85	151	56.3%	0
Nuclear	0	10	27	0	0	9	0	0	8	5	1	7	0	67	311	21.5%	0
Petroleum	0	0	22	6	0	0	1	0	5	0	0	0	5	39	161	24.2%	0
ENERGY-RELATED	2	59	505	118	9	31	12	4	66	33	68	56	21	984	4931	20.0%	44
Agricultural	0	2	7	3	4	2	2	0	0	1	8	8	3	40	157	25.5%	0
Architectural	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53	0	0
Ceramic	0	0	0	0	0	0	0	0	0	0	0	2	0	2	54	3.7%	0
Civil	4	21	542	85	12	11	12	4	22	26	56	87	7	889	3042	29.2%	0
Engineering Science	0	4	40	11	0	0	2	0	0	0	0	0	0	57	489	11.7%	28
General	0	0	449	1	0	0	0	0	0	4	0	16	0	470	727	64.6%	0
Industrial	3	18	144	0	0	0	9	0	6	7	11	0	0	198	1608	12.3%	0
Marine	0	0	17	0	8	0	0	0	0	0	0	0	0	25	174	14.4%	0
Materials Science	0	5	69	14	0	0	2	2	6	0	12	8	0	118	453	26.0%	0
Systems	0	11	97	0	0	0	0	0	0	0	0	0	0	108	437	24.7%	62
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	69	0	0
OTHER ENGINEERING	7	61	1365	114	24	13	27	6	34	38	87	121	10	1907	7263	26.3%	98
TOTAL ENGINEERING	9	170	2922	339	44	50	45	16	149	107	218	264	38	4371	17914	24.4%	249
COMPUTER SCIENCE (1979-80)																	
Comp & Info Science	0	12	488	36	13	2	0	0	23	35	20	31	0	660	3304	20.0%	0
Info Sci & Systems	0	15	1	0	0	0	0	0	0	0	0	0	0	16	210	7.6%	0
Data Processing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0
Computer Programming	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Systems Analysis	0	0	13	0	0	0	0	0	0	0	0	0	0	13	25	52.0%	0
TOTAL COMP SCIENCE	0	27	502	36	13	2	0	0	23	35	20	31	0	689	3545	19.4%	0
GEOLOGICAL SCIENCES (1979-80)																	
Geology	6	40	99	48	0	25	18	0	18	17	40	42	14	367	1192	30.8%	0
Geochemistry	0	0	0	5	0	0	1	0	0	0	0	0	0	6	8	75.0%	0
Geophysics & Seismol	0	0	25	17	0	0	0	0	1	1	7	4	0	55	95	57.9%	0
TOTAL GEOL SCIENCE	6	40	124	70	0	25	19	0	19	18	47	46	14	428	1295	33.1%	0

*Federal Control. These institutions are the Naval Postgraduate School in California and the United States Air Force Academy in Colorado. The Naval Postgraduate School awarded mostly master's degrees in 1980-81 and the Academy confers only bachelor's degrees.

Source: Engineering Manpower Commission and National Center for Education Statistics.

TABLE C

DOCTORAL DEGREES AWARDED
IN ENGINEERING, COMPUTER SCIENCE, AND GEOLOGICAL SCIENCES
IN THE WEST AND THE U.S.

	AK	AZ	CA	CO	HI	ID	MT	NV	NM	OR	UT	WA	WY	TOTAL WEST	U.S.	WEST AS % OF U.S.	FED* CONT'L (WEST)
ENGINEERING (1980-81)																	
Aerospace	0	1	20	2	0	0	0	0	0	0	0	4	0	27	114	23.7%	0
Bioengineering	0	0	7	0	0	0	0	0	0	0	3	0	1	11	54	20.4%	0
Computer	0	0	59	3	0	0	0	0	0	0	2	0	0	64	171	37.4%	0
Electrical	0	6	93	9	3	3	0	0	4	2	3	4	0	127	503	25.2%	1
HIGH TECHNOLOGY	0	7	179	14	3	3	0	0	4	2	8	8	1	229	842	27.2%	1
Chemical	0	3	30	12	0	1	0	0	0	2	10	3	1	62	312	19.9%	0
Environmental	0	0	3	6	0	0	0	0	0	0	1	0	1	11	49	22.4%	0
Mechanical	0	3	65	3	0	0	0	0	1	3	2	4	1	82	339	24.2%	0
Mining	0	2	0	23	0	0	0	0	0	0	1	0	0	26	45	57.8%	0
Nuclear	0	1	4	0	0	0	0	0	1	1	0	5	0	12	112	10.7%	0
Petroleum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0
ENERGY-RELATED	0	9	102	44	0	1	0	0	2	6	14	12	3	193	870	22.2%	0
Agricultural	0	0	6	9	0	1	0	0	0	0	1	0	0	17	52	32.7%	0
Architectural	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Ceramic	0	0	0	0	0	0	0	0	0	0	0	1	0	1	18	5.6%	0
Civil	0	5	65	22	0	2	0	0	2	4	7	9	1	117	357	32.8%	0
Engineering	0	0	33	1	0	0	0	0	0	0	0	0	0	34	187	18.2%	0
General	0	0	66	0	0	0	0	0	0	0	0	0	0	66	123	53.7%	0
Industrial	0	1	11	0	0	0	0	0	0	1	0	0	0	13	109	11.9%	0
Marine	0	0	5	0	2	0	0	0	0	0	0	0	0	7	22	31.8%	0
Materials Science	0	3	34	1	0	0	0	0	1	0	11	2	0	52	206	25.2%	0
Systems	0	4	9	0	0	0	0	0	0	0	0	0	0	13	48	27.1%	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0
OTHER ENGINEERING	0	13	229	33	2	3	0	0	3	5	19	12	1	320	1129	28.3%	0
TOTAL ENGINEERING	0	29	510	91	5	7	0	0	9	13	41	32	5	742	2841	26.1%	1
COMPUTER SCIENCE (1979-80)																	
Comp & Infor Sci	0	1	49	3	0	0	0	0	0	0	3	5	0	61	221	27.6%	0
Info Sci & Systems	0	0	1	0	0	0	0	0	0	0	0	0	0	1	18	5.6%	0
Data Processing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Computer Programming	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
System Analysis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
TOTAL COMP SCIENCE	0	1	50	3	0	0	0	0	0	0	3	5	0	62	240	25.8%	0
GEOLOGICAL SCIENCES (1979-80)																	
Geology	0	6	46	14	0	1	1	0	9	3	5	8	6	99	260	38.1%	0
Geochemistry	0	0	4	2	0	0	0	0	0	0	1	0	0	7	10	70.0%	0
Geophysics	0	0	13	6	0	0	0	0	2	0	0	4	0	25	43	58.1%	0
TOTAL GEOL SCIENCE	0	6	63	22	0	1	1	0	11	3	6	12	6	131	313	41.9%	0

*Federal Control. These institutions are the Naval Postgraduate School in California and the United States Air Force Academy in Colorado. The Naval Postgraduate School awarded mostly master's degrees in 1980-81 and the Academy confers only bachelor's degrees.

Source: Engineering Manpower Commission and National Center for Education Statistics.

TABLE D

ENGINEERING BACHELOR'S DEGREES AWARDED
IN THE WEST AND THE U.S.
1975-76 TO 1980-81

	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	Average Annual Percent Change
HIGH TECHNOLOGY ENGINEERING							
Rocky Mountain States	664	746	712	751	971	1039	11.3%
Pacific States (exc. Calif)	392	391	470	522	606	611	11.2%
California	1194	1213	1349	1490	1688	1976	13.1%
TOTAL WEST	2250	2350	2531	2763	3265	3626	12.2%
UNITED STATES	11774	12271	13614	15276	17189	18997	12.3%
WEST AS % OF U.S.	19.1%	19.2%	18.6%	18.1%	19.0%	19.1%	
ENERGY-RELATED ENGINEERING							
Rocky Mountain States	899	1038	1161	1386	1634	1763	19.2%
Pacific States (exc. Calif)	316	410	456	513	609	665	22.1%
California	715	895	1045	1221	1330	1498	21.9%
TOTAL WEST	1930	2343	2662	3120	3573	3926	20.7%
UNITED STATES	11412	12773	15590	18411	21148	23102	20.5%
WEST AS % OF U.S.	16.9%	18.3%	17.1%	16.9%	16.9%	17.0%	
OTHER ENGINEERING							
Rocky Mountain States	983	819	939	1072	1092	1259	5.6%
Pacific States (exc. Calif)	428	451	693	815	807	793	17.1%
California	1409	1522	1845	2009	2016	2186	11.0%
TOTAL WEST	2820	2792	3477	3896	3915	4238	10.1%
UNITED STATES	14784	15007	16887	18911	19780	20836	8.2%
WEST AS % OF U.S.	19.1%	18.6%	20.6%	20.6%	19.8%	20.3%	
TOTAL ENGINEERING							
Rocky Mountain States	2546	2603	2812	3209	3697	4061	11.9%
Pacific States (exc. Calif)	1136	1252	1619	1850	2022	2069	16.4%
California	3318	3630	4239	4720	5034	5660	14.1%
TOTAL WEST	7000	7485	8670	9779	10753	11790	13.7%
UNITED STATES	37970	40051	46091	52598	58117	62935	13.1%
WEST AS % OF U.S.	18.4%	18.7%	18.8%	18.6%	18.5%	18.7%	

Source: Engineering Manpower Commission.

TABLE E

ENGINEERING BACHELOR'S DEGREES AWARDED
IN THE WEST AND THE U.S.
EXPRESSED AS A PERCENT OF 1975-76 TOTALS

	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81
HIGH TECHNOLOGY ENGINEERING						
Rocky Mountain States	100	112	107	113	146	156
Pacific States (exc. Calif)	100	100	120	133	155	156
California	100	102	113	125	141	165
TOTAL WEST	100	104	112	123	145	161
UNITED STATES	100	104	116	130	146	161
ENERGY-RELATED ENGINEERING						
Rocky Mountain States	100	115	129	154	182	196
Pacific States (exc. Calif)	100	130	144	162	193	210
California	100	125	146	171	186	210
TOTAL WEST	100	121	138	162	185	203
UNITED STATES	100	112	137	161	185	202
OTHER ENGINEERING						
Rocky Mountain States	100	83	96	109	111	128
Pacific States (exc. Calif)	100	105	162	190	189	185
California	100	108	131	143	143	155
TOTAL WEST	100	99	123	138	139	150
UNITED STATES	100	102	114	128	134	141
TOTAL ENGINEERING						
Rocky Mountain States	100	102	110	126	145	160
Pacific States (exc. Calif)	100	110	143	163	178	182
California	100	109	128	142	152	171
TOTAL WEST	107	124	140	154	168	
UNITED STATES	100	105	121	139	153	166

Source: Engineering Manpower Commission.

TABLE F

ENGINEERING MASTER'S DEGREES AWARDED
IN THE WEST AND THE U.S.
1975-76 TO 1980-81

	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	Average Annual Percent Change
HIGH TECHNOLOGY ENGINEERING							
Rocky Mountain States	245	267	237	261	255	294	4.0%
Pacific States (exc. Calif)	121	120	123	109	88	134	2.1%
California	930	839	842	860	1134	1052	2.6%
TOTAL WEST	1296	1226	1202	1230	1477	1480	2.8%
UNITED STATES	5098	7243	5053	4995	5615	5720	2.4%
WEST AS % OF U.S.	25.4%	16.9%	23.8%	24.6%	26.3%	25.9%	
ENERGY-RELATED ENGINEERING							
Rocky Mountain States	262	312	365	322	357	379	8.9%
Pacific States (exc. Calif)	113	120	106	131	82	100	(2.3%)
California	438	505	475	466	514	505	3.1%
TOTAL WEST	813	937	946	919	953	984	4.2%
UNITED STATES	4362	4496	4441	4338	4710	4931	2.6%
WEST AS % OF U.S.	18.6%	20.8%	21.3%	21.2%	20.2%	20.0%	
OTHER ENGINEERING							
Rocky Mountain States	337	318	302	360	312	352	0.9%
Pacific States (exc. Calif)	174	156	146	189	207	190	1.8%
California	1361	1281	1282	1236	1227	1365	0.1%
TOTAL WEST	1872	1755	1730	1785	1746	1907	0.4%
UNITED STATES	7046	4490	6688	6703	6904	7263	0.6%
WEST AS % OF U.S.	26.6%	39.1%	25.9%	26.6%	25.3%	26.3%	
TOTAL ENGINEERING							
Rocky Mountain States	844	897	904	943	924	1025	4.3%
Pacific States (exc. Calif)	408	396	375	429	377	424	0.8%
California	2729	2625	2599	2562	2875	2922	1.4%
TOTAL WEST	3981	3918	3878	3934	4176	4371	2.0%
UNITED STATES	16506	16229	16182	16036	17229	17914	1.7%
WEST AS % OF U.S.	24.1%	24.1%	24.0%	24.5%	24.2%	24.4%	

Source: Engineering Manpower Commission

TABLE G

ENGINEERING MASTER'S DEGREES AWARDED
IN THE WEST AND THE U.S.
EXPRESSED AS A PERCENT OF 1975-76 TOTALS

	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81
HIGH TECHNOLOGY ENGINEERING						
Rocky Mountain States	100	109	97	107	104	120
Pacific States (exc. Calif)	100	99	102	90	73	111
California	100	90	91	92	122	113
TOTAL WEST	100	95	93	95	114	114
UNITED STATES	100	142	99	98	110	112
ENERGY-RELATED ENGINEERING						
Rocky Mountain States	100	119	139	123	136	145
Pacific States (exc. Calif)	100	106	94	116	73	88
California	100	115	108	106	117	115
TOTAL WEST	100	115	116	113	117	121
UNITED STATES	100	103	102	99	108	113
OTHER ENGINEERING						
Rocky Mountain States	100	94	90	107	93	104
Pacific States (exc. Calif)	100	90	84	109	119	109
California	100	94	94	91	90	100
TOTAL WEST	100	94	92	95	93	102
UNITED STATES	100	64	95	95	98	103
TOTAL ENGINEERING						
Rocky Mountain States	100	106	107	112	109	121
Pacific States (exc. Calif)	100	97	92	105	92	104
California	100	96	95	94	105	107
TOTAL WEST	100	98	97	99	105	110
UNITED STATES	100	98	98	97	104	109

Source: Engineering Manpower Commission

TABLE H

ENGINEERING DOCTORAL DEGREES AWARDED

IN THE WEST AND THE U.S.
1975-76 TO 1980-81

	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	Average Annual Percent Change
HIGH TECHNOLOGY ENGINEERING							
Rocky Mountain States	35	27	37	49	28	37	1.1%
Pacific States (exc. Calif)	21	16	15	22	9	13	(7.6%)
California	176	159	179	192	173	179	0.3%
TOTAL WEST	232	202	231	263	210	229	(0.3%)
UNITED STATES	919	1052	820	877	829	842	(1.7%)
WEST AS % OF U.S.	25.2%	19.2%	28.2%	30.0%	25.3%	27.2%	
ENERGY-RELATED ENGINEERING							
Rocky Mountain States	51	62	53	53	66	73	8.6%
Pacific States (exc. Calif)	17	17	11	11	15	18	1.2%
California	126	73	83	88	115	102	(3.8%)
TOTAL WEST	194	152	147	152	196	193	(0.1%)
UNITED STATES	903	812	742	838	827	870	(0.7%)
WEST AS % OF U.S.	21.5%	18.7%	19.8%	18.1%	23.7%	22.2%	
OTHER ENGINEERING							
Rocky Mountain States	70	54	44	60	67	72	0.6%
Pacific States (exc. Calif)	24	25	19	27	22	19	(4.2%)
California	222	248	215	217	207	229	0.6%
TOTAL WEST	316	327	278	304	296	320	0.3%
UNITED STATES	1155	910	1011	1100	1097	1129	(0.5%)
WEST AS % OF U.S.	27.4%	35.9%	27.5%	27.6%	27.0%	28.3%	
TOTAL ENGINEERING							
Rocky Mountain States	156	143	134	162	161	182	3.3%
Pacific States (exc. Calif)	62	58	45	60	46	50	(3.9%)
California	524	480	477	497	495	510	(0.5%)
TOTAL WEST	742	681	656	719	702	742	0
UNITED STATES	2977	2774	2573	2815	2753	2841	(0.9%)
WEST AS % OF U.S.	24.9%	24.5%	25.5%	25.5%	25.5%	26.1%	

Source: Engineering Manpower Commission

TABLE I

ENGINEERING DOCTORAL DEGREES AWARDED
IN THE WEST AND THE U.S.
EXPRESSED AS A PERCENT OF 1975-76 TOTALS

	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81
HIGH TECHNOLOGY ENGINEERING						
Rocky Mountain States	100	77	106	140	80	106
Pacific States (exc. Calif)	100	76	71	105	43	62
California	100	90	102	109	98	102
TOTAL WEST	100	87	100	113	91	99
UNITED STATES	100	114	89	95	90	92
ENERGY-RELATED ENGINEERING						
Rocky Mountain States	100	122	104	104	129	143
Pacific States (exc. Calif)	100	100	65	65	88	106
California	100	58	66	70	91	81
TOTAL WEST	100	78	76	78	101	99
UNITED STATES	100	90	82	93	92	96
OTHER ENGINEERING						
Rocky Mountain States	100	77	63	86	96	103
Pacific States (exc. Calif)	100	104	79	113	92	79
California	100	112	97	98	93	103
TOTAL WEST	100	103	88	96	94	101
UNITED STATES	100	79	88	95	95	98
TOTAL ENGINEERING						
Rocky Mountain States	100	92	86	104	103	117
Pacific States (exc. Calif)	100	94	73	97	74	81
California	100	92	91	95	94	97
TOTAL WEST	100	92	88	97	95	100
UNITED STATES	100	93	86	95	92	95

Source: Engineering Manpower Commission

TABLE J

COMPUTER SCIENCE AND GEOLOGICAL SCIENCES BACHELOR'S DEGREES AWARDED
IN THE WEST AND THE U.S.
1975-76 TO 1979-80

	1975-76	1976-77	1977-78	1978-79	1979-80	Average Annual Percent Change
COMPUTER SCIENCE						
Rocky Mountain States	299	325	359	415	566	22.3%
Pacific States (exc. Calif)	110	144	170	217	274	37.3%
California	432	491	518	637	860	24.8%
TOTAL WEST	841	960	1047	1269	1700	25.5%
UNITED STATES	5593	6370	7157	8693	11135	24.8%
WEST AS % OF U.S.	15.0%	15.1%	14.6%	14.6%	15.3%	
GEOLOGICAL SCIENCES						
Rocky Mountain States	293	428	471	478	557	22.5%
Pacific States (exc. Calif)	161	188	156	172	184	3.6%
California	356	362	409	393	461	7.4%
TOTAL WEST	810	978	1036	1043	1202	12.1%
UNITED STATES	3358	3879	4342	4502	4597	9.2%
WEST AS % OF U.S.	24.1%	25.2%	23.9%	23.2%	26.1%	

Source: National Center for Education Statistics

TABLE K

COMPUTER SCIENCE AND GEOLOGICAL SCIENCES BACHELOR'S DEGREES AWARDED
IN THE WEST AND THE U.S.
EXPRESSED AS A PERCENT OF 1975-76 TOTALS

	1975-76	1976-77	1977-78	1978-79	1979-80
COMPUTER SCIENCE					
Rocky Mountain States	100	109	120	139	189
Pacific States (exc. Calif)	100	131	155	197	249
California	100	114	120	147	199
TOTAL WEST	100	114	124	151	202
UNITED STATES	100	114	128	155	199
GEOLOGICAL SCIENCES					
Rocky Mountain States	100	146	161	163	190
Pacific States (exc. Calif)	100	117	97	107	114
California	100	102	115	110	129
TOTAL WEST	100	121	128	129	148
UNITED STATES	100	116	129	134	137

Source: National Center for Education Statistics

TABLE L

COMPUTER SCIENCE AND GEOLOGICAL SCIENCES MASTER'S DEGREES AWARDED
IN THE WEST AND THE U.S.
1975-76 TO 1979-80

	1975-76	1976-77	1977-78	1978-79	1979-80	Average Annual Percent Change
COMPUTER SCIENCE						
Rocky Mountain States	61	91	100	99	108	19.3%
Pacific States (exc. Calif)	68	76	74	82	79	4.0%
California	355	328	363	359	502	10.4%
TOTAL WEST	484	495	537	540	689	10.6%
UNITED STATES	2545	2724	2969	2980	3545	9.8%
WEST AS % OF U.S.	19.0%	18.2%	18.1%	18.1%	19.4%	
GEOLOGICAL SCIENCES						
Rocky Mountain States	122	162	167	179	234	23.0%
Pacific States (exc. Calif)	41	49	71	74	70	17.7%
California	79	105	117	118	124	14.2%
TOTAL WEST	242	316	355	371	428	19.2%
UNITED STATES	1003	1047	1239	1300	1295	7.3%
WEST AS % OF U.S.	24.1%	30.2%	28.7%	28.5%	33.1%	

Source: National Center for Education Statistics

TABLE M

COMPUTER SCIENCE AND GEOLOGICAL SCIENCES MASTER'S DEGREES AWARDED
IN THE WEST AND THE U.S.
EXPRESSED AS A PERCENT OF 1975-76 TOTALS

	1975-76	1976-77	1977-78	1978-79	1979-80
COMPUTER SCIENCE					
Rocky Mountain States	100	149	164	162	177
Pacific States (exc. Calif)	100	112	109	121	116
California	100	92	102	101	141
TOTAL WEST	100	102	111	112	142
UNITED STATES	100	107	117	117	139
GEOLOGICAL SCIENCES					
Rocky Mountain States	100	133	137	147	192
Pacific States (exc. Calif)	100	120	173	180	171
California	100	133	148	149	157
TOTAL WEST	100	131	147	153	177
UNITED STATES	100	104	124	130	129

Source: National Center for Education Statistics

TABLE N

COMPUTER SCIENCE AND GEOLOGICAL SCIENCE DOCTORAL DEGREES AWARDED
IN THE WEST AND THE U.S.
1975-76 TO 1979-80

	1975-76	1976-77	1977-78	1978-79	1979-80	Average Annual Percent Change
COMPUTER SCIENCE						
Rocky Mountain States	7	5	6	8	7	0
Pacific States (exc. Calif)	5	2	5	5	5	0
California	36	35	33	36	50	9.7%
TOTAL WEST	48	42	44	49	62	7.3%
UNITED STATES	244	216	196	236	240	(0.4%)
WEST AS % OF U.S.	19.7%	19.4%	22.4%	20.8%	25.8%	
GEOLOGICAL SCIENCES						
Rocky Mountain States	28	42	26	25	53	22.3%
Pacific States (exc. Calif)	20	15	14	18	15	(6.3%)
California	37	60	43	50	63	17.6%
TOTAL WEST	85	117	83	93	131	13.5%
UNITED STATES	313	325	268	286	313	0
WEST AS % OF U.S.	27.2%	36.0%	31.0%	32.5%	41.9%	

Source: National Center for Education Statistics

TABLE O

COMPUTER SCIENCE AND GEOLOGICAL SCIENCES DOCTORAL DEGREES AWARDED
IN THE WEST AND THE U.S.
EXPRESSED AS A PERCENT OF 1975-76 TOTALS

	1975-76	1976-77	1977-78	1978-79	1979-80
COMPUTER SCIENCE					
Rocky Mountain States	100	71	86	114	100
Pacific States (exc. Calif)	100	40	100	100	100
California	100	97	92	100	139
TOTAL WEST	100	88	92	102	129
UNITED STATES	100	89	80	97	98
GEOLOGICAL SCIENCES					
Rocky Mountain States	100	150	93	89	189
Pacific States (exc. Calif)	100	75	70	90	75
California	100	162	116	135	170
TOTAL WEST	100	138	98	109	154
UNITED STATES	100	104	86	91	100

Source: National Center for Education Statistics

TABLE P

NUMBER AND PERCENT OF
TOTAL ENGINEERING DEGREES AWARDED TO FOREIGN NATIONALS
IN THE WEST AND THE U.S. 1980-81

	PUBLIC						PRIVATE					
	BACHELOR'S		MASTER'S		DOCTOR'S		BACHELOR'S		MASTER'S		DOCTOR'S	
HIGH TECHNOLOGY												
Rocky Mountain States	62	(6.4%)	58	(21.4%)	7	(19.4%)	0		1	(4.3%)	0	
Pacific States (exc. Calif)	26	(4.8%)	30	(24.4%)	4	(30.8%)	24	(34.8%)	8	(72.7%)	0	
California	139	(8.6%)	106	(22.9%)	25	(32.9%)	85	(23.4%)	145	(24.6%)	43	(41.7%)
TOTAL WEST	227	(7.3%)	194	(22.6%)	36	(28.8%)	109	(21.8%)	154	(24.7%)	43	(41.3%)
UNITED STATES	961	(7.5%)	784	(25.8%)	161	(36.1%)	577	(10.0%)	505	(20.5%)	127	(32.2%)
ENERGY-RELATED												
Rocky Mountain States	130	(7.8%)	99	(25.3%)	30	(44.1%)	2	(2.3%)	2	(7.4%)	0	
Pacific States (exc. Calif)	16	(2.6%)	24	(30.3%)	2	(11.1%)	18	(39.1%)	4	(80.0%)	0	
California	77	(6.3%)	81	(28.6%)	30	(44.8%)	57	(21.3%)	65	(27.3%)	12	(34.3%)
TOTAL WEST	223	(6.3%)	204	(28.6%)	62	(40.5%)	77	(19.2%)	71	(26.3%)	12	(30.0%)
UNITED STATES	1205	(7.3%)	872	(27.9%)	221	(37.9%)	600	(9.5%)	454	(26.0%)	107	(37.3%)
OTHER ENGINEERING												
Rocky Mountain States	133	(11.3%)	95	(28.8%)	40	(55.6%)	4	(4.7%)	2	(9.1%)	0	
Pacific States (exc. Calif)	44	(6.7%)	27	(15.0%)	4	(21.1%)	55	(40.7%)	8	(80.0%)	0	
California	285	(16.1%)	264	(32.2%)	57	(37.8%)	76	(18.3%)	201	(36.8%)	24	(30.8%)
TOTAL WEST	462	(12.8%)	386	(29.0%)	101	(41.7%)	135	(21.2%)	211	(36.5%)	24	(30.8%)
UNITED STATES	1666	(10.8%)	1312	(29.1%)	295	(41.4%)	538	(11.4%)	694	(26.6%)	142	(34.9%)
TOTAL ENGINEERING												
Rocky Mountain States	325	(8.5%)	252	(26.4%)	77	(43.7%)	6	(2.5%)	5	(6.9%)	0	
Pacific States (exc. Calif)	86	(4.7%)	81	(20.4%)	10	(20.0%)	97	(38.8%)	20	(76.9%)	0	
California	501	(10.9%)	451	(29.1%)	112	(38.1%)	218	(20.8%)	411	(30.0%)	79	(36.6%)
TOTAL WEST	912	(8.9%)	784	(27.0%)	199	(38.3%)	321	(20.9%)	436	(29.6%)	79	(35.6%)
UNITED STATES	3832	(8.5%)	2968	(27.8%)	677	(38.9%)	1715	(10.2%)	1653	(24.3%)	376	(34.5%)

Percentages indicate proportion of foreign national students receiving degrees in that geographical region; i.e., 961 foreign nationals received bachelor's degrees in public institutions in high technology fields in the United States in 1980-81. This represents 7.5 percent of all high technology bachelor's degrees awarded by public institutions in the nation.

Source: Engineering Manpower Commission

TABLE Q

ASSOCIATE DEGREES AWARDED
IN MECHANICAL AND ENGINEERING TECHNOLOGIES (1)
IN THE WEST AND THE U.S.
1979-1980

	AK	AZ	CA	CO	HI	ID	MT	NV	NM	OR	UT	WA	WY	TOTAL WEST	U.S.	WEST AS % OF U.S.
MECHANICAL & ENGINEERING TECHNOLOGIES																
Aeronautical	8	31	466	20	6	0	0	0	19	34	1	102	0	687	2411	28.5%
Electrnc/Off.Mach.(2)	24	284	1364	284	57	49	5	19	19	183	112	215	17	2632	10024	26.3%
Electromechanical	0	12	114	20	0	0	0	0	0	10	6	4	0	166	1538	10.8%
Instrumentation	0	0	16	65	0	3	0	0	4	14	27	8	0	137	478	28.7%
HIGH TECHNOLOGY	32	327	1960	389	63	52	5	19	42	241	146	329	17	3622	14451	25.1%
Chemical	0	1	15	0	0	0	0	0	1	8	0	5	0	30	661	4.5%
Mechanical	0	6	107	43	21	13	0	0	0	47	1	25	3	266	2060	12.9%
Nuclear	0	0	0	0	0	0	0	0	0	0	0	8	0	8	113	7.1%
ENERGY-RELATED	0	7	122	43	21	13	0	0	1	55	1	38	3	304	2834	10.7%
OTHER TECHNOLOGIES (3)	71	194	2511	481	301	78	42	47	92	568	203	749	61	5398	23749	22.7%
TOTAL	103	528	4593	913	385	143	47	66	135	864	350	1116	81	9324	41034	22.7%

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1. This table includes both engineering and industrial technology graduates. Although the distinctions between the two areas are ill-defined, basically, the graduate from an industrial technology program has received a skill-based education and is employed in a repair or maintenance position. The engineering technology graduate has received an education more oriented to problem solving and provides technical support to engineers. The exact number of Engineering Technicians included in these data is impossible to determine.

2. Electronics and Office Machine Technologies: this category includes an exceptionally large number of industrial technology graduates. (See footnote 1.)

3. Other Mechanical and Engineering Technologies: technology curricula not included in high technology or energy-related above. These technologies include:

- Mechanical and Engineering Technologies, General
- Engineering Graphics
- Welding Technologies
- Architectural Drafting Technologies
- Automotive Technologies
- Diesel Technologies
- Civil Technologies (including surveying)
- Industrial Technologies (different from the definition given in footnote 1)
- Textile Technologies
- Construction and Building Technologies
- Mechanical and Engineering Technologies, other

Source: National Center for Education Statistics

TABLE R

UNDERGRADUATE ENGINEERING ENROLLMENTS
IN THE WEST AND THE U.S.
FALL, 1981

	AK	AZ	CA	CO	HI	ID	MT	NV	NM	OR	UT	WA	WY	TOTAL WEST	U.S.
ENGINEERING															
Aerospace	0	624	1304	300	0	0	0	0	0	0	0	103	0	2331	13037
Bioengineering	0	53	588	0	0	0	0	0	66	0	0	9	43	759	3550
Computer	0	241	3453	108	0	0	0	0	406	904	594	25	1	5732	18319
Electrical	84	2008	9184	1801	477	366	417	232	1400	451	1598	1105	227	19350	96099
HIGH TECHNOLOGY	64	2926	14529	2209	477	366	417	232	1872	1355	2192	1242	271	28172	131005
Chemical	0	539	1412	805	0	119	383	57	461	278	694	271	124	5143	36825
Environmental	0	0	445	0	0	0	85	0	21	0	0	0	0	551	1171
Mechanical	70	1202	5961	847	266	251	346	165	892	884	1178	1013	205	13280	76588
Mining	61	257	13	1102	0	179	308	121	180	0	188	1	2	2412	5071
Nuclear	0	124	124	0	0	0	0	0	31	76	0	0	0	355	2251
Petroleum	90	0	102	422	0	0	0	0	231	0	0	0	388	1233	8206
ENERGY-RELATED	221	2122	8057	3176	266	549	1122	343	1816	1238	2060	1285	719	22974	130112
Agricultural	0	29	196	53	0	28	51	0	38	68	39	119	36	657	3367
Architectural	0	0	185	192	0	31	0	0	0	0	0	443	127	978	3137
Ceramic	0	0	0	0	0	0	0	0	0	0	0	51	0	51	1076
Civil	246	803	4795	727	299	218	333	200	629	1008	1102	1006	281	11647	48503
Engineering Science	0	181	873	315	0	0	142	12	0	84	0	165	0	1772	6912
General	0	184	7785	661	125	268	137	273	820	510	103	1681	2	12549	69661
Industrial	0	221	981	2	0	0	89	0	98	237	47	54	0	1729	16205
Marine	0	0	56	0	0	0	0	0	0	0	0	0	0	56	2810
Materials Science	0	82	203	131	0	44	65	34	60	0	118	151	0	388	3903
Systems	0	189	61	0	0	0	0	0	0	0	0	0	0	250	1343
Other	0	80	214	4	0	0	0	0	0	0	0	0	0	298	1818
OTHER ENGINEERING	246	1769	15349	2085	424	589	817	519	1545	1907	1409	3670	446	30875	158735
TOTAL ENGINEERING	551	6817	37935	7470	1167	1504	2356	1094	5333	4500	5661	6197	1436	82021	419852

Enrollment is student headcount, both full- and part-time students.

Source: Engineering Manpower Commission

TABLE S

GRADUATE ENGINEERING ENROLLMENTS
IN THE WEST AND THE U.S.
FALL, 1981

	AK	AZ	CA	CO	HI	ID	MT	NN	NM	OR	UT	WA	WY	TOTAL WEST	U.S.
ENGINEERING															
Aerospace	0	19	278	35	0	0	0	0	0	0	0	76	0	408	1918
Bioengineering	0	0	110	0	0	0	0	0	0	0	43	0	9	162	965
Computer	0	0	1733	137	0	0	0	0	78	0	112	94	0	2154	6754
Electrical	1	440	2379	232	30	18	23	11	218	159	137	208	24	3880	17018
HIGH TECHNOLOGY	1	459	4500	404	30	18	23	11	296	159	292	378	33	6604	26655
Chemical	0	85	423	169	0	18	23	0	70	32	102	86	15	1023	6366
Environmental	15	0	66	88	0	0	8	0	0	0	0	0	19	196	1547
Mechanical	0	152	1274	112	23	7	10	6	83	117	109	139	11	2043	10081
Mining	9	67	0	296	0	27	16	16	4	0	14	0	4	453	884
Nuclear	0	30	64	0	0	4	0	0	31	13	0	47	0	189	1313
Petroleum	0	0	75	35	0	0	2	0	5	0	0	0	16	133	714
ENERGY-RELATED	24	334	1902	700	23	56	59	22	193	162	225	272	65	4037	20905
Agricultural	0	4	42	38	17	10	0	0	0	12	36	19	2	180	748
Architectural	0	0	0	0	0	0	0	0	0	0	0	0	0	0	108
Ceramic	0	0	0	0	0	0	0	0	0	0	0	9	0	9	223
Civil	9	150	1486	391	19	21	20	13	87	125	183	307	26	2837	10750
Engineering Science	0	31	320	32	0	0	4	0	0	0	0	0	0	387	2514
General	0	510	1490	65	0	0	0	33	0	21	0	35	1	2155	3773
Industrial	3	136	372	0	0	0	11	0	23	14	79	0	0	638	5423
Marine	0	0	38	0	20	0	0	0	0	0	0	0	0	58	477
Materials Science	1	24	363	67	0	4	5	7	10	0	77	62	0	621	3077
Systems	0	83	183	0	0	0	0	0	0	0	0	0	0	266	1327
Other	0	0	0	2	0	0	0	0	0	0	0	0	0	2	861
OTHER ENGINEERING	13	938	4294	595	56	35	41	53	120	172	375	432	29	7153	29281
TOTAL ENGINEERING	38	1731	10696	1699	109	109	123	86	609	493	892	1082	127	17794	76841

Enrollment is student headcount, both full- and part-time students.

Source: Engineering Manpower Commission

TABLE T

ENGINEERING UNDERGRADUATE ENROLLMENTS
IN THE WEST AND THE U.S.
FALL 1976 TO FALL 1981

	1976	1977	1978	1979	1980	1981	Average Annual Percent Change
HIGH TECHNOLOGY ENGINEERING							
Rocky Mountain States	4740	6036	6861	7692	9117	10485	24.2%
Pacific States (exc. Calif)	2268	2561	2611	2933	3130	3158	7.8%
California	7013	7727	10134	11509	12799	14529	21.4%
TOTAL WEST	14021	16324	19606	22134	25046	28172	20.2%
UNITED STATES	73737	83328	93996	104808	120171	131005	15.5%
WEST AS % OF U.S.	19.0%	19.6%	20.9%	21.1%	20.8%	21.5%	
ENERGY-RELATED ENGINEERING							
Rocky Mountain States	6606	8920	9407	9987	11207	11907	16.0%
Pacific States (exc. Calif)	1914	2307	2541	2759	2877	3010	11.5%
California	5057	5411	6945	6920	7712	8057	11.9%
TOTAL WEST	13577	16638	18893	19666	21796	22974	13.8%
UNITED STATES	79512	91974	102110	110959	122228	130112	12.7%
WEST AS % OF U.S.	17.1%	18.1%	18.5%	17.7%	17.8%	17.7%	
OTHER ENGINEERING							
Rocky Mountain States	7336	8304	7722	8595	8826	9279	5.3%
Pacific States (exc. Calif)	4449	5487	5480	6635	5275	6247	8.1%
California	11239	12665	12989	14023	14718	15349	7.3%
TOTAL WEST	23024	26456	26191	29253	28819	30875	6.8%
UNITED STATES	124430	134580	137974	150532	154945	158735	5.5%
WEST AS % OF U.S.	18.5%	19.7%	19.0%	19.4%	18.6%	19.5%	
TOTAL ENGINEERING							
Rocky Mountain States	18682	23260	23990	26274	29150	31671	13.9%
Pacific States (exc. Calif)	8631	10355	10632	12327	11282	12415	8.8%
California	23309	25803	30068	32452	35229	37935	12.5%
TOTAL WEST	50622	59418	64690	71053	75661	82021	12.4%
UNITED STATES	277679	309882	334080	366299	397344	419852	10.2%
WEST AS % OF U.S.	18.2%	19.2%	19.4%	19.4%	19.0%	19.5%	

Source: Engineering Manpower Commission

TABLE U

ENGINEERING GRADUATE ENROLLMENTS
IN THE WEST AND THE U.S.
FALL 1976 TO FALL 1981

	1976	1977	1978	1979	1980	1981	Average Annual Percent Change
HIGH TECHNOLOGY ENGINEERING							
Rocky Mountain States	1062	1243	1145	1091	1288	1536	8.9%
Pacific States (exc. Calif)	479	497	490	534	583	568	3.7%
California	3581	4053	4376	3973	4234	4500	5.1%
TOTAL WEST	5122	5793	6011	5598	6105	6604	5.8%
UNITED STATES	20561	21523	21147	22577	24650	26655	5.9%
WEST AS % OF U.S.	24.9%	26.9%	28.4%	24.8%	24.8%	24.8%	
ENERGY-RELATED ENGINEERING							
Rocky Mountain States	1030	1361	1350	1361	1674	1654	12.1%
Pacific States (exc. Calif)	372	367	391	374	457	481	5.9%
California	1619	1822	1823	1804	1965	1902	3.5%
TOTAL WEST	3021	3550	3564	3539	4096	4037	6.7%
UNITED STATES	16670	17648	17013	18434	19824	20905	5.1%
WEST AS % OF U.S.	18.1%	20.1%	20.9%	19.2%	20.7%	19.3%	
OTHER ENGINEERING							
Rocky Mountain States	1436	1595	1334	1715	1684	2186	10.4%
Pacific States (exc. Calif)	690	560	651	650	656	673	(0.5%)
California	3977	3733	3943	3859	4721	4294	1.6%
TOTAL WEST	6103	5888	5928	6224	7061	7153	3.4%
UNITED STATES	26090	25129	24354	26141	28111	29281	2.5%
WEST AS % OF U.S.	23.4%	23.4%	24.3%	23.8%	25.1%	24.4%	
TOTAL ENGINEERING							
Rocky Mountain States	3528	4199	3829	4167	4646	5376	10.5%
Pacific States (exc. Calif)	1541	1424	1532	1558	1696	1722	2.3%
California	9177	9608	10142	9636	10920	10696	3.3%
TOTAL WEST	14246	15231	15503	15361	17262	17794	5.0%
UNITED STATES	63321	64300	62514	67152	72585	76841	4.3%
WEST AS % OF U.S.	22.5%	23.7%	24.8%	22.9%	23.8%	23.2%	

Source: Engineering Manpower Commission